COMBUSTION

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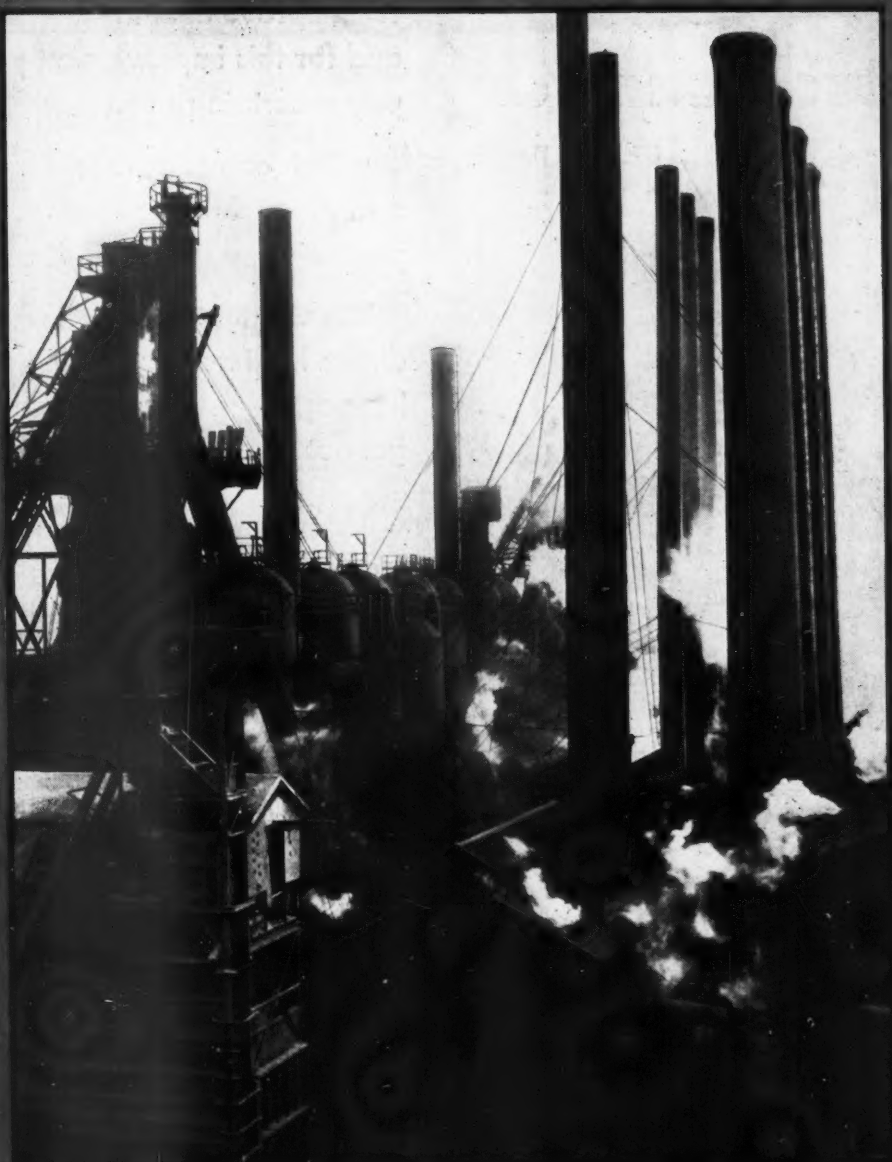

OTIS STEEL COMPANY

The New Industrial South
By JOHN M. GALLALEE

The Engineer and his place in our Industrial Society
By MARTIN E. POPKIN

Other Articles in This Issue by
T. A. PEEBLES • H. W. BROOKS • DAVID BROWNLIE • B. J. CROSS

COMBUSTION

Vol. 1 OCTOBER 1929 No. 4

CONTENTS

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COMBUSTION

Vol. 1 October 1929 No. 4

Technically Trained Leaders in Industry

COL. PETER JUNKERSFELD

STEAM railroads of 60 years ago, and the early public utilities, had relatively few executives with engineering education, training or experience. The original leaders came from various pursuits, and later on a considerable number rose from the ranks. Many executives, especially of railroads, had their earlier training in the law.

Since those years, there has been a vast growth in the business transacted by these public services and in the size of their organizations. This growth has resulted in a tremendous broadening of the problems encountered, with an increase in technical complexity not dreamed of by the founders.

The annual gross income of steam railroads in the United States prior to 1870, and of the public utilities prior to 1900, was relatively small, but in 1928 such incomes had increased to about 6 billion dollars for Class I railroads, and to about 5 billion dollars for central station electric companies, electric railways, and the gas, telephone and telegraph services.

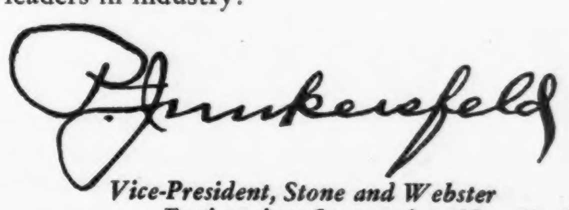
At the beginning of the two periods referred to, there was a lack of technically trained men. Only a few colleges and universities offered courses in engineering, and those were limited largely to surveying and similar primary subjects. Few men with even this limited technical training were available and practically none were fitted for the principal executive responsibilities.

Today the railroads and utilities employ large numbers of engineering graduates. These men are employed not merely as technical artisans to carry on complex engineering routine work, but as men whose scientific training has prepared them to expand into positions of executive responsibility.

The grouping of railroads some 30 years ago into large systems and the prospective grouping at this time into still larger systems, together with the modern merging of public utilities, reduces somewhat the number of heads of systems and heads of principal divisions, but should not appreciably reduce the total number of technically trained men required or limit their opportunities for advancement. The increase in technically trained executives and department heads in the manufacturing industries, partly because of their larger number and greater range of activities, has been greater than in railroads and public utilities.

Today, a steadily growing proportion of men with engineering training and experience is needed in all industries, and correspondingly more are reaching the higher positions. Men with college education in engineering form a larger and larger proportion of the presidents, vice-presidents and department heads of railroads, public utilities and manufacturing enterprises.

A college engineering education is not absolutely necessary for success, to be sure. But the advantages of possessing accurate scientific knowledge, and a training of the mind in absorbing, classifying and applying knowledge, are proving of downright value in the personal equipment of modern executives. It is because those special qualities of mind essential to industrial leadership are supplemented and strengthened in action by scientific training and suitable experience, that today the trend is strongly toward technically trained leaders in industry.



Vice-President, Stone and Webster Engineering Corporation, New York

EDITORIAL

The Future of Fuel Burning

FUEL burning has long been regarded merely as an economic problem. The huge utility plants burn their thousands of tons per hour with heroic effort to conserve the highest possible percentage of the stored energy of the fuel. Factories burn fuel as a raw material whose energy translated into power or heat enters into their manufactured products. Householders consume their small individual quotas of fuel, the total of which is enormous, chiefly with the object of producing heat for their health and comfort. The cost of fuel for these different uses varies widely, and the efficiency of combustion has a wide range; but the whole scheme of fuel burning is on an established economic basis, a *status quo* largely accepted as necessary.

There are influences at work which may change this whole scheme. Electric power generating stations have made it more economical for the average user to buy electricity than to make it from a primary fuel. Central heating plants have demonstrated the economy of steam distribution from a central source for heating residences and larger buildings. The combination of these two enterprises, for increased mutual economies, is opening up as a probable major development in the near future. Low temperature carbonization has entered the field as a further factor in conservation of the inherent values of fuel. The conclusion looms large that an era is approaching for consolidations of such enterprises as these into far more compact and economical central units for producing electricity, steam and gas.

The present motive for such a move will be economic. Such concentrations will be organized because the cost of production and distribution can be reduced, which is the basic reason for practically all present consolidations of business enterprises.

But there is a further influence that is making itself felt with increasing force. The cinders and the noxious gases that are being distributed in tremendous quantity from all the chimneys, both large and small, constitute a menace to the public health. That the magnitude of the menace is being partially appreciated is evidenced by the present activities against the contamination of the atmosphere by smoke. The contamination by noxious gases will inevitably be taken up in due course.

The problem of sewage disposal has been satisfactorily worked out and has wide successful application. The menace of polution from this source has been removed by the modern disposal plants of such municipalities as have installed them. Garbage disposal by completely sanitary incinerator plants is perhaps not quite as widely adopted throughout the country, but the dangers from unsanitary disposal of garbage are well recognized, and the movement toward sanitary disposal is rapidly gaining ground. Water supply has been safeguarded for the public health in almost every municipal instance.

Activity on behalf of the public health against contamination of the air by fuel burning, is now handicapped by the great difficulty of bringing into line the many thousands of small fuel users, and by the fact that mechanical equipment for completely eliminating atmospheric polution, is not commercially developed in sizes suitable for these small installations. The final result of the effort to eliminate atmospheric polution, must be the absolute removal from the gases that issue from all chimneys of both the cinders and the noxious elements. It is obvious that this program will be infinitely more practical when the cleansing of gases from fuel burning is concentrated in a comparatively few large central stations.

The economic motive and the necessity for safeguarding public health are two powerful forces having direct influence upon the trend of fuel burning. A further feature of today's economic trend is constant acceleration in the combination of business units into large consolidations. These factors are sufficient warrant for the prediction that the future of fuel burning will include the elimination of small fuel burning plants, and the concentration of fuel burning in large central stations, which will produce electricity, steam and gas, with greatly improved economy and with full regard for public sanitation.

Thriving Companies

A STUDY of nearly 1,000 companies in more than 25 lines of industry, indicates that their last average year's business showed about 9 per cent gain in current assets, about 9 per cent gain in net working capital, and about 19 per cent increase in their cash and marketable securities. Students of economics will recognize these items as the health signs of corporate management.

The principles of business are evidently in harmony with the demands of modern civilization. Profit is not only the mark of good management, but is also the stamp of approval by society at large. These thriving companies are creating economic values, raising our standards of living, and spreading their good measure of wages and income to many thousands of people.

Brooklyn Bridge, New York City—An engineering work typifying the engineer's contribution to social progress

The Engineer *and* His Place *in* Our Industrial Society

By M. E. POPKIN
Consulting Engineer, New York

THE engineer and his place in our social economy is assuming greater significance than ever before.

There are many who believe that his "recent" entrance into public service and government administration has focused the attention of the world upon him, more so than were he to confine his activities to purely technical pursuits. This is not at all the case. The engineer has held office in public service from the very inception of our Government. Mr. Herbert Hoover, our illustrious contemporary, is not the only engineer who has enjoyed the highest office which our country can grant. Several presidents of our country, beginning with George Washington, were engineers.

We have at the present time numerous engineers actively engaged in government administration. They are Governors of State, are in the Senate, the House of Representatives, and in Congress. In 1920 there were but two Governors with engineering training; there are now twelve. In the United States Senate of the 70th Congress, there were five with engineering training or experience; in 1920 there were only two. In 1910 the House of Representatives included nine Representatives with engineering training or experience; in 1920 the House had a representation of fifteen with technical training or experience; the House of Representatives of the 70th Congress in 1929 contained a total of twenty-one members with engineering training or experience.

In view of these facts, we can hardly conclude that the engineer's entrance into public service is recent, nor can we accept the supposition that current public cognizance is the effect of his presence in public life. On the contrary, his place in public administration is the result and not the cause of popular approval in his behalf.

There is great need for our "taking stock" occasionally. Engineers are a fast increasing regiment of the body politic. How do we assay in fineness of worth to that society which we serve? Can we do more than the tasks for which we have considered ourselves trained? Is our value greater to civilization than merely as the creators, fabricators, and operators of her machinery? The author guides us boldly into this interesting stock taking.

Our present generation is witnessing a highly organized consciousness in government and social economy that is definitely manifest at every turn. The intimate relationship existing between the purely sociological factors in our daily life and the influence which our industrial economy has upon it, are unquestionably apparent.

The student of history knows that man has

throughout the ages conjectured much upon the possible ends to which we are striving. He has considered the values and relationships between purely metaphysical indulgences and the tilling of the soil, craftsmanship, and finally, industrialization. To all of his interrogations concerning the *ultimo-termine* of his fellow men, he has only the ever-present testimony of the continued search. One fact, however, has definitely asserted itself. There remains no doubt that the lives of a people are intimately entwined with the industrialism of their era. The very foundation of our present society is our highly industrialized economy. With this realization we can more clearly understand the important part which the engineer is destined to play in the world's activities.

Engineering as we know it today is a relatively young profession, notwithstanding the fact that we have magnificent examples of engineering science and skill applied ages ago. When compared with medicine and jurisprudence, the science and particularly the application of engineering has only begun. In contradistinction to other professions and their practice, engineering and the scope of the engineer is understood comparatively but very little by the general public. There is, however, a rapidly growing realization that the professional engineer is a pertinent factor in our economic structure.

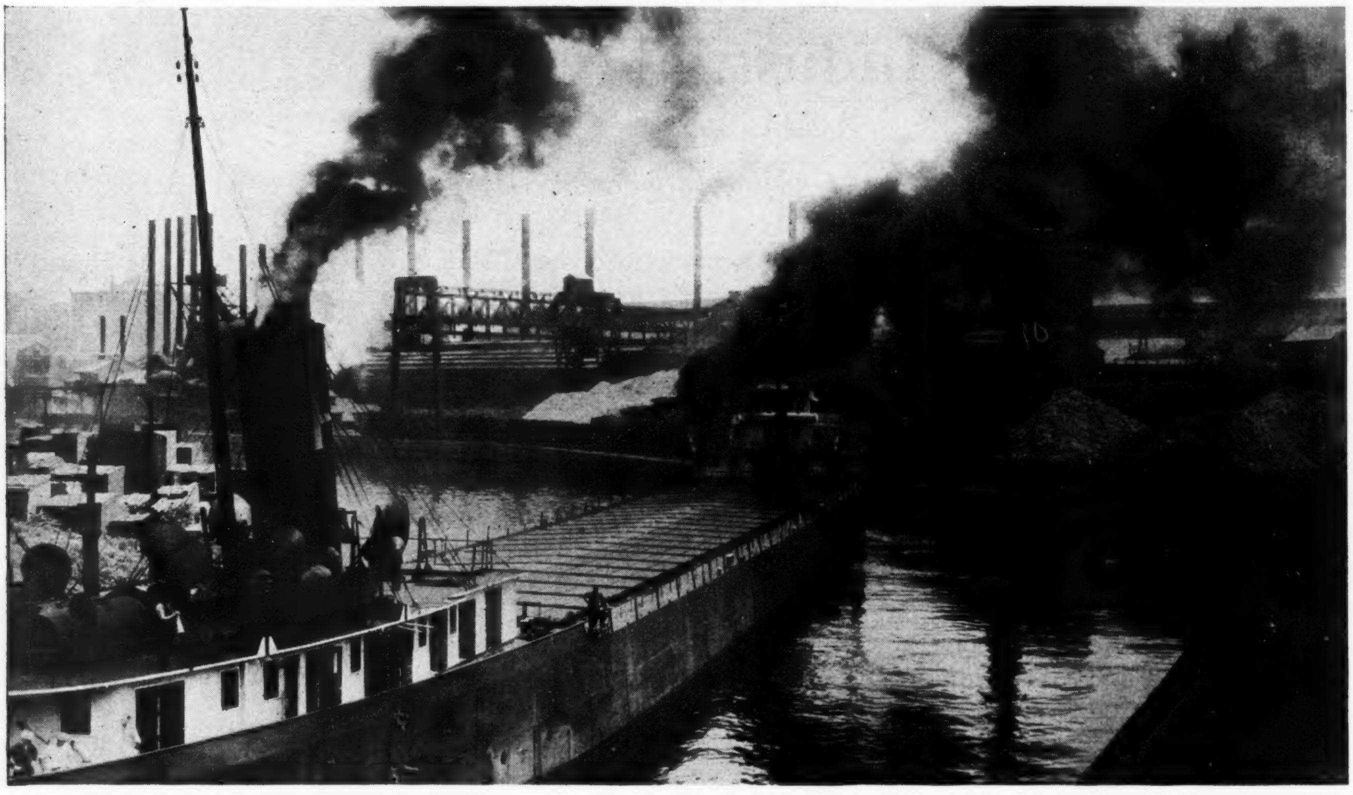
Social economists who have questioned the relationship between man and his machines have definitely come to the conclusion that the machine has not only become but must continue to remain the indispensable tool of man.

Russia, which ten years ago condemned the machine as the mortal Nemesis of man, today acknowledges the tool and the machine as the very emblem of its order, and the foundation of its future welfare. This observation is of more than passing interest because it significantly and irrevocably associates the engineer and the character of his work with our whole social economy.

The engineer has played an unostentatious part on the stage of the world's work, while preoccupied with the development and application of his science in the service of humanity. It is unfortunate that the true nature and scope of his work has been so little understood. There are many who still do not understand the character of service which his profession equips him to render.

The locomotive engineer, the stationary and marine engine operator, along with the professional, civil, mechanical, electrical, mining and chemical engineer, are all referred to as engineers. This general reference leaves the layman somewhat confused. In a broad sense, however, the public at large is learning to distinguish between a professional engineer and engine operators of one kind or another. Yet much remains to be done in an educational way in order that the distinction may be more clearly appreciated.

A story goes the rounds in connection with our President, Mr. Hoover, that is as amusing as it is



Cleveland ore docks—A chapter in the epic of steel *Photo by Ewing Galloway*

instructive. Mr. Hoover, on his last day aboard ship during his many travels, sat at table with a very charming lady who questioned him regarding the nature of his profession or business, whereupon he advised the lady that he was an engineer. "Why, I thought you were a gentleman," replied the lady with a surprised and innocent air.

At this point it may be of interest to delve into the origin of the term "engineer." We find on investigation that the old Oxford English dictionary tells an interesting story of words referring to our profession. The word "engine" is related to the Latin "ingenium" and to the Anglo-Saxon "ingenious." It first signified native talent and it was also used in the senses of "skill in contriving" and "ingenuity." Later it was used in a transferred sense of "product of ingenuity." It subsequently narrowed itself to "a mechanical contrivance," or "a machine with parts working together to produce a given physical effect."

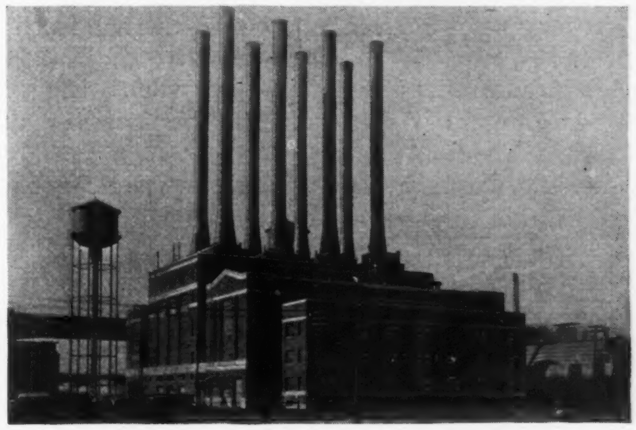
The word "engineer," that is, "one who is concerned with engines," has varied similarly in meaning. It first denoted a "contriver or designer or inventor." Later it was applied to constructors of military works, then to designers and constructors of works of public utility who were named "civil engineers" in distinction from military engineers.

With the advance in the development of engines and machines as a supplement to man's work, the scope of the engineer was appreciated and defined as "the application of the forces and materials of nature to the benefit of the human race."

With a fuller realization of the intimate relationship between the engineer and our whole social structure, the accepted definition of "engineering" today is: "The art of organizing and directing men and controlling the forces and materials of nature for the benefit of the human race."*

The iconoclast may consider so broad a definition platitudinous. To consider whether this is so, we need only concern ourselves with the activities which require the attention of the engineer and their manifold character. We find that we can trace practically every crystallized industrial activity to the organizing elements concurrent with the principles of engineering application and practice. Is it not true that after we run the whole gamut of sociological "isms" we find that they resolve themselves down to a question of values and relationships between man in an industrialized society and industrialism as such? The engineer and the physicist in contradistinction to many "statistical economists" and as many sociologists, do not fear the advent of the machine, its influence on the social structure, or its ultimate effect as a whole on society.

Whether the engineer or the sociologist is in a better position to judge the matter may be left for the time being in conjecture. We only know that the tools and machines which the engineer creates do not frighten him, because he thoroughly understands them, is cognizant of their capabilities and definitely conscious of their limitations. In all probability the greatest contribution which the engineer has made to society in the past is ways and means for placing the sparsely attainable within reach of everyone and thereby popularizing the exclusive, ordinarily confined to a minority. By this service the engineer has contributed greatly, if not supremely, to the elements comprising a democracy.



Fordson Plant, Ford Motor Company—Engineering converts coal into power, to serve industry

The important problem before us today is the factor of considering means for intelligently and adequately controlling the relationship which necessarily exists between production and consumption and this problem cannot be solved without major consideration of the engineer's place in government and public administration.

We are only around the corner from the time when it will be required that public administrators have training and abilities of a character more suitable to the requirements of their office, than that concurrent with purely political aspirations and prejudices. We have shown the marked increase in engineering talent in public administration of high office. Is it not logical to suppose that city managers, commissioners of roads, parks and so forth should be men with engineering training?

In 1924 we find that the United States Shipping Board had some thirteen hundred ships available, practically all of which were not in service. Do we need to recite what was accomplished in the way of building up a Merchant Marine? Have we not a right to suppose that engineering talent might have accomplished much in the way of building a Merchant Marine, in which we have failed so miserably?

The engineer is frequently informed that duties of public service require a knowledge of legal matters not possessed by the engineer. This is pure nonsense. The law, which in the major part is built upon precedent, can be hardly argued as a curriculum difficult to achieve by the technically trained mind of the engineer. In my personal contact with officials

*From an address by Henry Gordon Stott made in 1908 to the A.I.E.E. Refer Vol. XXVII, Part II, Page 1396.

of large corporate interests, it has never amazed me to find their grasp on matters which the layman and the politican consider of vital legal importance.

I desire to emphasize particularly that a society striving as it generally does for leisure and comfort, supplemented by the joys of creative effort in behalf of humanity, cannot afford to ignore the supreme part which the professional engineer has in such an organized structure.

It may be of interest to quote from "The Decline of the West," by Oswald Spengler, the world's greatest pessimist:

"The center of the artificial and complicated realm of the machine is the organizer and manager. The mind, not the hand, holds it together. But, for that very reason, to preserve the ever-endangered structure, one figure is even more important than all the energy of enterprising master men that makes cities to grow out of the ground and alter the picture of the landscape; it is a figure that is apt to be forgotten in this conflict of politics—the *engineer*, the priest of the machine, the man who knows it. Not merely the importance but the very existence of the industry depends upon the existence of the hundred thousand talented, rigorously schooled brains that command the technique and develop it onward and onward.

"The quiet engineer it is who is the machine's master and destiny. His thought is as possibility what the machine is as actuality. There have been fears, thoroughly materialistic fears, of the exhaustion of the coal fields. But as long as there are worthy technical pathfinders, dangers of this sort have no existence.

"When, and only when, the crop of recruits for this army fails—this army whose thought-work forms one onward unit with the work of the machine—then industry must flicker out in spite of all that managerial energy and the workers can do. Suppose that, in future generations, the most gifted minds were to find their souls' health more important than all the powers of this world; suppose that, under the influence of the metaphysic and mysticism that is taking the place of rationalism today, the very elite of intellect that is now concerned with the machine comes to be overpowered by a growing sense of its Satanism (it is the step from Roger Bacon to Bernard of Clairvaux)—then nothing can hinder the end of this grand drama that has been a play of intellects, with hands as mere auxiliaries."

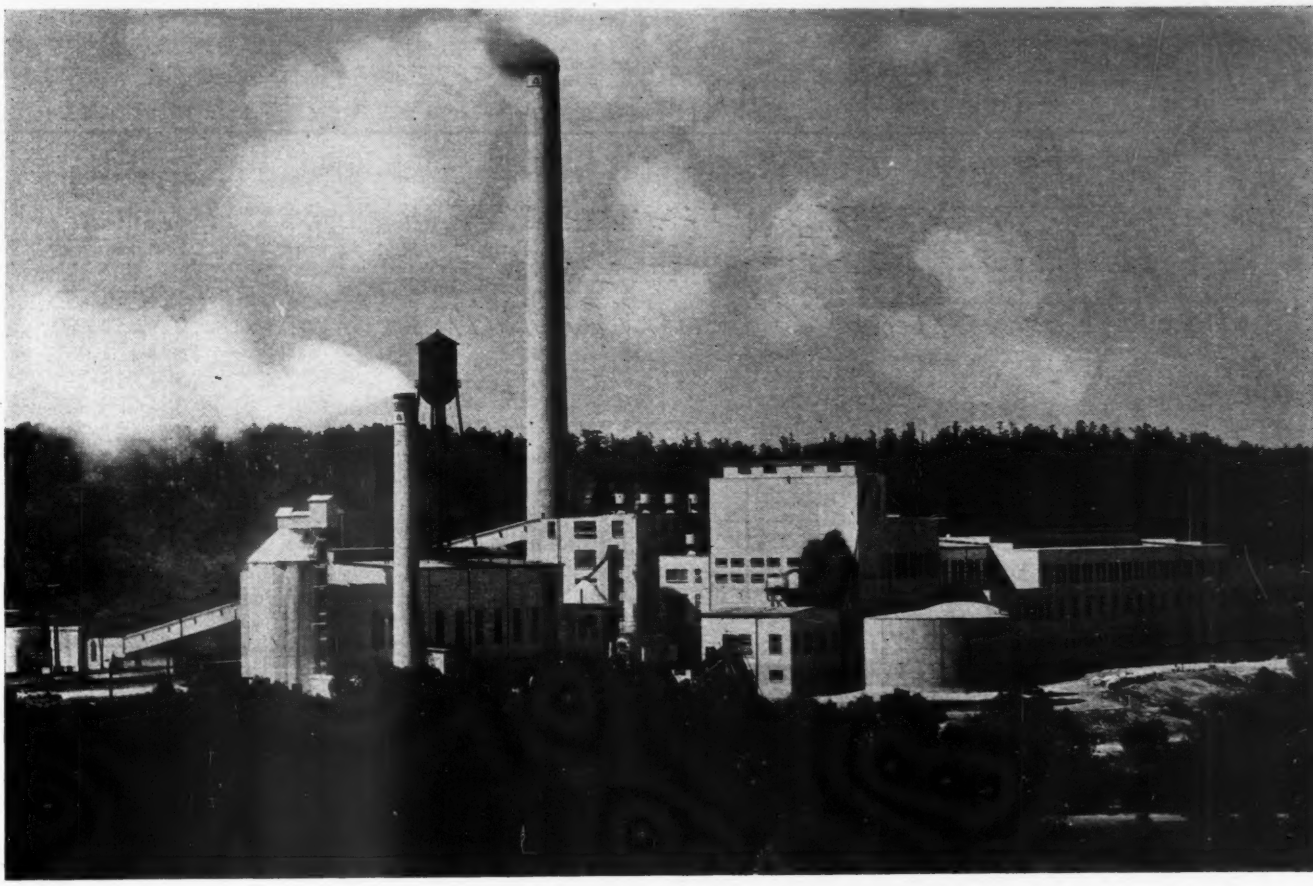
In this unique work of Spengler, one finds much food for thought. He analyzes the economic structure of a society much in the manner of the engineer, with the exception that he blends it throughout with a pessimistic philosophy with which the engineer would hardly agree.

In studying the significance of the above quotation from his work we may realize how intensely conscious the thinkers of the world are becoming of the relationship that naturally exists between the engineer and our society. Spengler is not presenting a revelation, but his statement is the more significant when one thoroughly appreciates the pessimistic character of his philosophy.

Workers the world over who fear or conjecture about the industrialization of society need only understand that those men who have made it possible to bring the treasures of the earth at our feet, who have enabled us to talk across unknown seas and continents, may be depended upon to cooperate intelligently in the development of a society that will consider human welfare as supreme.

For this very reason the scientist and the engineer must play an important part in the advance of civil government.

Sky Line of New York—A product of modern engineering



Plant of Gulf States Paper Company, Tuscaloosa, Alabama

The New Industrial South

By John M. Gallalee
Professor of Mechanical Engineering, University of Alabama

IN that immense area which we call the South, extending from the southern borders of Pennsylvania, Ohio, Indiana, Illinois, Iowa and Kansas to the Gulf of Mexico, and from the Atlantic Ocean to the western border of Texas, comprising in all 969,000 square miles, or about 32 per cent of the area of the United States, and nearly 41,000,000 people, 97 per cent American born, there has occurred in recent years the most marked development of any section of our country. The South was formerly an agricultural section; it is now both an agricultural and an industrial section.

It is difficult to write of the remarkable industrial progress of this section and of the effect of this progress on the life of its people without seeming to exaggerate, and it s also difficult, for so arge a region, to name with accuracy the forces which occasioned the development, and to determine its future trend.

The wealth of statistical information here presented by Prof. Gallalee tells an epic story in itself of the remarkable industrial growth of the South. This story is explained with great clarity and considerable restraint in the accompanying text, so that the statements made are conservative. The picture is not overdrawn. Grateful acknowledgement is due the editor of the Manufacturers Record for permission to reprint certain of the statistical material contained herein.

The value of the manufactured products of the South is about one-sixth of the value of the manufactured products of the United States, but the South creates one-third of the mineral and one-third of the agricultural wealth of the country.

From 1910 to 1928 the population of the South increased from 32,000,000 to 40,000,000, about 25 per cent; in the same period the value of the manufactured products increased from about $3,000,000,000 to over $10,000,000,000, an increase of 233 per cent, while the value of the mineral products increased from $369,000,000 to $1,836,000,000, or an increase of nearly 400 per cent.

Perhaps a clearer conception of the economic conditions of the South can be obtained from Table IV which compares the Scuth today with the whole United States in 1900, and which gives, by percentages, the South's increase in the period 1900-1928. It is only by such a

TABLE I

Productive Power of the South

STATES	Manufactured Products Value	Mineral Products Value	Agricultural Products Value	Gross Value All Products
Alabama	$550,372,126	$78,641,000	$264,002,000	$893,015,126
Arkansas	182,750,871	59 449,000	265,142,000	507,341,871
District of Columbia	90,389,537	....	....	90,389,537
Florida	218,790,152	18,096,000	112,265,000	349,151,152
Georgia	609,917,660	16,756,000	308,758,000	935,431,660
Kentucky	447,764,961	152,614,000	293,795,000	894,173,961
Louisiana	638,361,215	51,267,000	205,288,000	894,916,215
Maryland	943,410,896	20,469,000	100,209,000	1,064,088,896
Mississippi	196,640,742	2,554,000	278,998,000	478,192,742
Missouri	1,665,173,463	75,890,000	515,830,000	2,256,893,463
North Carolina	1,154,646,612	11,652,000	382,899,000	1,549,197,612
Oklahoma	371,718,409	524,595,000	431,236,000	1,327,549,409
South Carolina	358,334,205	4,251,000	180,219,000	542,804,205
Tennessee	612,040,524	37,785,000	290,415,000	942,330,524
Texas	1,206,579,962	374,503,000	1,184,669,000	2,765,751,962
Virginia	671,346,808	41,320 000	250,138,000	962,804,808
West Virginia	451,555,334	366,643,000	120,783,000	938,981,334
Total	$10,371,793,477	$1,836,575,000	$5,184,646,000	$17,393,014,477
United States	62,721,375,881	5,520,000,000	15,045,930,000	83,287,305,881

Figures for manufacturing are for latest census year, 1927, as well as those for mineral products, while agricultural products are the estimates for 1928.

TABLE II

Manufacturing in the Southern States, 1927

STATES	Number of Establishments	Wage Earners*** (Average** for the Year)	Primary Horsepower	Cost of Materials, Fuel and Power	Value of Products
Alabama	2,355	111,093	697,998	$317,493,407	$550,372,126
Arkansas	1,146	40,032	177,011	103,815,280	182,750,871
District of Columbia	503	9,519	37,508	36,098,635	90,389,537
Florida	1,912	61,219	144,161	91,715,524	218,790,152
Georgia	3,175	154,168	523,334	360,261,684	609,917,660
Kentucky	1,851	74,912	257,965	250,632,957	447,764,961
Louisiana	1,625	82,415	410,298	427,994,341	638,361,215
Maryland	3,205	126,700	544,558	564,120,437	943,410,896
Mississippi	1,333	50,569	211,691	105,559,493	196,640,742
Missouri	5,422	195,378	590,485	1,004,709,373	1,665,173,463
North Carolina	2,984	204,590	800,051	560,819,236	1,154,646,612
Oklahoma	1,373	27,932	156,826	269,418,221	371,718,409
South Carolina	1,059	108,992	423,359	206,772,453	358,334,205
Tennessee	2,098	114,968	447,529	351,436,325	614,040,524
Texas	4,065	116,763	572,798	842,927,286	1,206,579,962
Virginia	2,432	114,918	441,807	346,165,769	671,346,808
West Virginia	1,313	77,630	431,981	249,558,180	451,555,334
Total	37,851	1,679,798	6,869,360	$ 6,089,498,601	$10,371,793,477
United States	191,866	8,353,325	35,772,628	35,136,184,129	62,721,375 881

*Preliminary estimates compiled by the Bureau of Census. **Total persons engaged not tabulated by States. ***Census, 1925, later figures not available at time of going to press.

statistical comparison as this that the amazing progress can be grasped.

Table I shows the wealth produced by the several southern states contrasted with the wealth produced by the United States.

Table II shows the latest census returns on manufacturing, and Table III the comparison of the South with the United States.

The foregoing table presenting the productive power of the South in manufacturing, mining and agriculture, and the comparison of the economic position of the South today with relation to the United States in 1900, at which time the world was beginning to recognize the wealth-creative power of the United States and the magnitude of its productive capacity, strikingly emphasize the commanding position the Southern States have attained in the business life of the nation.

Though so much has been accomplished, there is no indication of a retardation of progress, but every indication that past records will be surpassed and that industrial development will continue at an accelerated pace. The entire South, from Maryland and Virginia to Texas and Oklahoma, gives evidence of present progress and of great future accomplishments. The mind is dazed by a contemplation of the wealth which will be created, and by thoughts of the increase in material well-being which will accrue to the peop e of the section.

Marble quarry at Sylacauga, Alabama

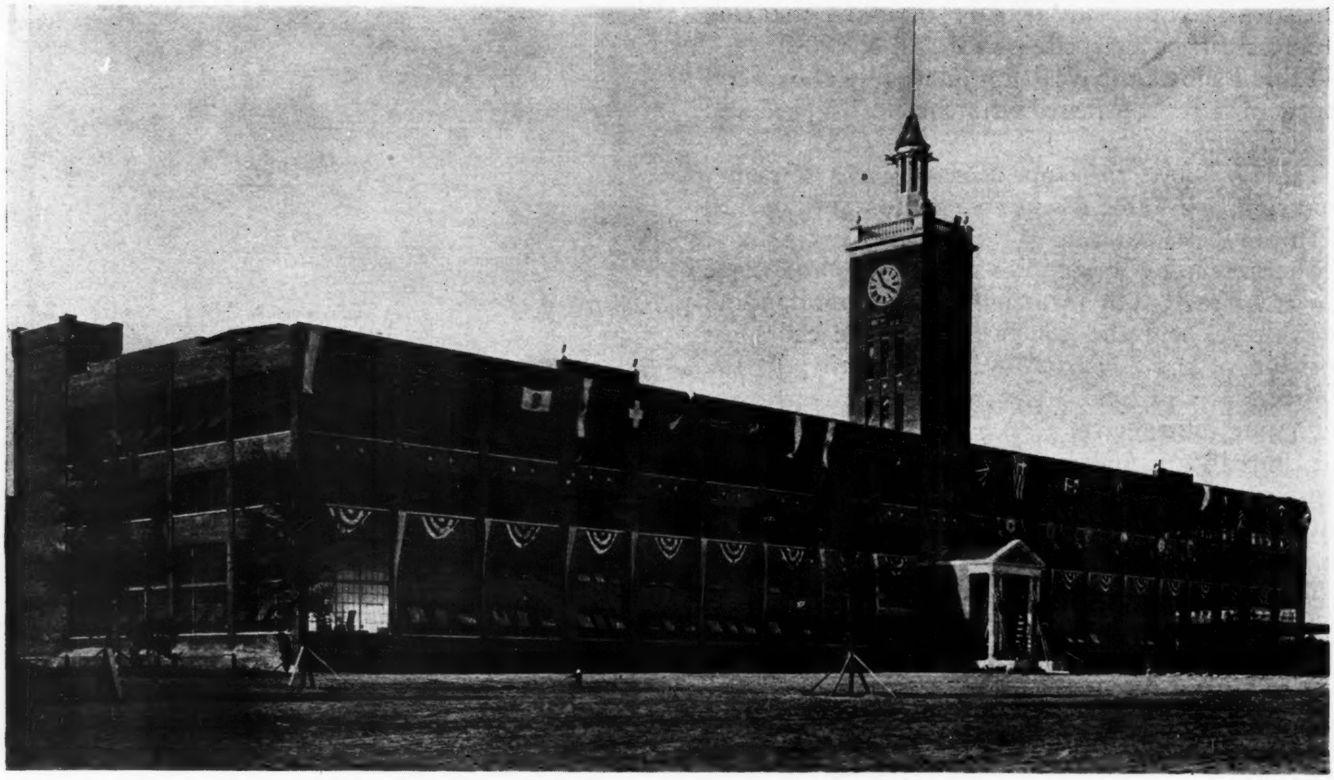
Some indication of what remains to be accomplished in the industrialization of the South and what may be expected of the future can be obtained by contrasting some parts of the South with older industrial sections of the country. Alabama is larger than Pennsylvania by 6,400 square miles, and in soil, in minerals, in iron and coal, in rivers and water port, and in potential power supply from water or fuel it is as favorably gifted as Pennsylvania to support industrial development. Yet in 1927 Alabama produced manufactured products to the value

TABLE III

Comparative Statistics Concerning Manufacturers

	1909	1914	1919	*1927
Number of Establishments:				
South	63,457	63,330	66,464	37,851
United States	268,491	275,791	290,105	191,866
Wage Earners, Average Number:				
South	1,261,062	1,291,687	1,597,684	1,679,798
United States	6,615,046	7,036,337	9,096,372	8,353,325
Primary Horsepower:				
South	4,029,599	4,724,634	5,788,813	**6,869,360
United States	18,675,376	22,547,574	29,410,192	**35,772,628
Capital:				
South	$2,885,928,000	$3,498,936,000	$6,883,171,000	***
United States	18,428,270,000	22,790,979,000	44,569,594,000	***
Wages:				
South	514,772,000	604,990,000	1,529,009,000	1,553,220,000
United States	3,427,038,000	4,078,332,000	10,533,400,000	10,729,469,000**
Cost of Materials:				
South	1,831,772,000	2,274,052,000	6,093,108,000	6,089,498,601
United States	12,142,791,000	14,368,089,000	37,376,380,000	35,136,184,129
Value of Products:				
South	3,158,389,000	3,768,123,000	9,805,041,000	10,371,793,477
United States	20,672,052,000	24,246,435,000	62,418,079,000	62,721,375,881
Value Added by Manufacture:				
South	1,326,617,000	1,494,072,000	3,711,433,000	4,145,020,000
United States	8,529,261,000	9,878,346,000	25,041,698,000	26,774,566,000

*Census 1927 excludes all plants producing less than $5,000 annually and automobile repairing establishments, which in 1919 numbered 75,722, with products valued at $376,304,000. **1925, figures for 1927 not available at time of going to press. ***Not compiled for 1927.



Goodyear Tire and Rubber Company, Gladsden, Alabama

of only $550,372,126, compared to $6,715,563,455 for Pennsylvania, or less than one-tenth as much.

The three States of Alabama, North Carolina and Georgia, which have been leaders in the South's industrial developmen have more than one and one-half t mes the combined areas of Massachusetts, Pennsylvania and Ohio. They are richer in natural resources than the three Northern States, but they produced in 1927 manufactured products to the value of only $2,314,936,398, or about one-seventh of the $15,263,738,611 produced by the three Northern States.

These figures are not discreditable to the South; contrasted with those of the immediate past they are highly creditable, but they do indicate what must be accomplished before the South can measure up industrially with other sections of the country, and when viewed in connection with its natural resources they serve to show the vast possibilities for the continued industrial progress of the section.

TABLE IV

The South Today Compared with the United States in 1900

	The United States 1900	The Southern States 1928	South's Increase, 1900-1928 (%)
Population	75,994,000	40,631,000	48
Wealth	$88,517,307,000	$80,000,000,000	346
Manufactured products	$11,406,926,000	$10,371,793,000	563
Lumber	$760,992,000	$*555,737,000	137
Cotton	$339,200,000	$*908,690,000	816
Furniture	$130,634,000	$*145,872,000	836
Mineral products	$1,108,936,000	$*1,836,575,000	1314
Coal, tons	269,684,000	243,190,000	346
Petroleum, barrels	63,620,000	573,443,000	3253
Farm products	$4,717,000,000	$5,184,646,000	231
Exports, value	$1,394,483,000	$1,631,690,000	236
Imports, value	$849,941,000	$501,986,000	863
Banking resources	$10,785,800,000	$10,362,292,000	850
Deposits	$7,288,900,000	$7,479,722,000	981
Railroad mileage	193,346	92,117	49
Highway expenditures	$30,000,000	$390,220,000	2986
Public school expenditures	$214,964,000	$**426,200,421	1116

*Census 1927. **1926.

LABOR SUPPLY

The people of the South must be named as foremost among the factors which have caused this remarkable industrial progress and they are the foundation stone on which its future must be built. Today they are "industrially minded," and there is a realization among all of them, including the farmer, that industrial development and industrial payrolls are the creators of general prosperity and the cause of the wide diffusion of material necessities, comforts and luxuries. They are a skillful people; they have inherited from the Old South the scientific, managerial and manual skill which caused the South to lead the country in manufacturing prior to the invention of the cotton gin. The well-to-do carried their skill in management to the large plantations where slaves were taught to perform the manual labor, and the poorer whites carried their manual skill to the small farms of the hill country to which slave labor drove them. A great portion of this skill has now returned to industry. The South's labor supply is unsurpassed. When properly directed as individuals by those who know them, who understand them, and who in understanding like them, the productivity of white labor and of negro labor equals that of any other section of the country. The Southern white man of small means has a realization of his worth as an individual, and this worth is recognized by all who know and understand him. Any type of industrial management which does not take into account the worth of the "common man" as an individual in the South is doomed to failure.

The supply of native labor increases faster than the demand of labor for industries; there has been no immigration, and present indications are that there will be no increase in the foreign born percentage of

TABLE V

Percentage Native White of Native American Percentage, Percentage Foreign White Stock, Foreign Born and Negroes to Total Population, by States and Geographical Divisions
(*Census*, 1920)

STATES	Total Population	Per Cent Native White of Native Percentage	Per Cent Native White*	Per Cent Foreign Born White	Per Cent White Foreign Stock**	Per Cent Negro
Alabama	2,348,174	59.4	60.9	0.8	2.2	38.4
Arkansas	1,752,204	70.0	72.2	0.8	3.0	27.0
District of Columbia	437,571	54.7	68.2	6.5	19.0	25.1
Florida	968,470	55.0	61.5	4.4	10.9	30.4
Georgia	2,895,832	56.7	57.8	0.6	1.6	41.7
Kentucky	2,416,630	84.4	89.0	1.3	5.8	9.8
Louisiana	1,798,509	52.4	58.5	2.5	8.6	38.9
Maryland	1,449,661	61.6	76.1	7.0	21.0	16.9
Mississippi	1,790,618	46.2	47.2	0.4	1.5	52.2
Missouri	3,404,055	74.5	89.3	5.5	20.2	5.2
North Carolina	2,559,123	69.0	69.4	0.3	0.7	29.8
Oklahoma	2,028,283	82.8	87.8	2.0	7.0	7.4
South Carolina	1,683,724	47.5	48.2	0.4	1.0	51.4
Tennessee	2,337,885	78.4	80.0	0.7	2.2	19.3
Texas	4,663,228	66.7	76.3	7.7	17.2	15.9
Virginia	2,309,187	66.5	68.7	1.3	3.0	29.9
West Virginia	1,463,701	84.2	89.9	4.2	9.0	5.9
Total South	36,306,855	66.7	72.0	2.7	8.0	24.9
GEOGRAPHIC DIVISIONS						
New England	7,400,909	37.9	73.6	25.3	60.0	1.1
Middle Atlantic***	22,484,147	43.4	74.9	22.0	53.0	2.8
E. North Central	21,475,543	54.9	82.5	15.0	42.0	2.4
W. North Central****	9,140,194	54.0	85.4	12.9	44.0	0.1
South Atlantic***	13,767,269	62.7	66.6	2.1	6.0	31.1
E. South Central	8,893,307	68.5	70.8	0.8	3.0	28.4
W. South Central****	13,646,279	69.5	78.3	4.7	13.5	16.4
Mountain	3,336,101	60.0	82.7	13.6	36.0	0.9
Pacific	5,566,871	51.9	77.6	18.6	44.0	0.9
United States	105,710,620	55.3	76.7	13.0	34.4	9.9

*Includes all white American born children of foreign parents. **Includes white foreign born and children of either one or both parents foreign born. ***Delaware included in Middle Atlantic States. ****Missouri included in West South Central States.

TABLE VI

Estimated Coal Resources and Area 1924

STATES	Estimated Coal Land Area (Sq. Miles)	Lignite and Sub-bituminous Coal (Short Tons)	Bituminous, Semi-bituminous, Semi-anthracite and Anthracite Coal (Short Tons)	**Total Coal Reserves (Short Tons)
Alabama	*8,500	....	67,500,000,000	67,500,000,000
Arkansas	*1,700	90,000,000	1,800,000,000	1,890,000,000
Georgia	170	....	925,000,000	925,000,000
Kentucky	*16,000	....	123,000,000,000	123,000,000,000
Louisiana	*	....	....	....
Maryland	510	....	8,000,000,000	8,000,000,000
Mississippi	*	....	....	....
Missouri	*23,000	....	84,000,000,000	84,000,000,000
North Carolina	800	....	200,000,000	200,000,000
Oklahoma	15,000	....	55,000,000,000	55,000,000,000
Tennessee	*4,400	....	25,500,000,000	25,500,000,000
Texas	*11,000	23,000,000,000	8,000,000,000	31,000,000,000
Virginia	2,120	....	22,000,000,000	22,000,000,000
West Virginia	17,300	....	152,500,000,000	152,500,000,000
Total	100,500	**23,090,000,000	548,425,000,000	**571,515,000,000
United States	496,776	2,033,594,000,000	1,518,212,000,000	3,551,806,000,000

*No estimate available as to the area of lignite-bearing lands. **Includes estimate of lignite for Arkansas and Texas only.

2.7 per cent. Table V shows statistics on population and therefore on labor supply, compared to other sections of the country.

CLIMATE

The climate of the South has contributed to its progress. For general business, and especially for industrial operations, it is an important fact that the South has a longer daylight period during the winter and a shorter daylight period in the summer than have other industrial sections of the country. The mild winter climate prevailing over most of the region makes factories, housing and clothing cost less than in other sections of the country and permits a more healthful outdoor life to the wage earner and his family. The summer days are hot, but not so hot that men and women cannot and do not perform a good day's work without undue fatigue. The nights are usually cool; sleeping porches, open houses, space between dwellings, trees, and in general plenty of pure and fresh cool air in Southern industrial towns cause the worker to be refreshed and ready for his

TABLE VII

Southern Coal Production

STATES	1900 Tons	1910 Tons	1927 Tons	*1928 Tons
Alabama	8,394,275	16,111,462	19,766,000	17,400,000
Arkansas	1,447,945	1,905,958	1,549,000	1,800,000
Georgia	315,557	177,245	....	....
Kentucky	5,328,964	14,623,319	69,124,000	63,255,000
Maryland	4,024,688	5,217,125	2,815,000	2,780,000
Missouri	3,540,103	2,982,433	3,064,000	3,400,000
North Carolina	17,734	....	....	....
Oklahoma	1,922,298	2,646,226	3,818,000	3,050,000
Tennessee	3,509,562	7,121,380	5,783,000	5,680,000
Texas	968,373	1,892,176	1,326,000	895,000
Virginia	2,393,754	6,507,997	12,916,000	12,330,000
West Virginia	22,647,207	61,671,019	145,122,000	132,600,000
Total	54,510,460	120,856,340	265,283,000	243,190,000
United States	269,684,027	501,596,378	**597,859,000	***569,489,000

*Preliminary estimate, Bureau of Mines. **Includes 80,096,000 tons of Pennsylvania anthracite. ***Includes 76,734,000 tons of Pennsylvania anthracite.

task in the morning. The Southern negro lives, sleeps and works in more comfort than the same class of labor in other sections.

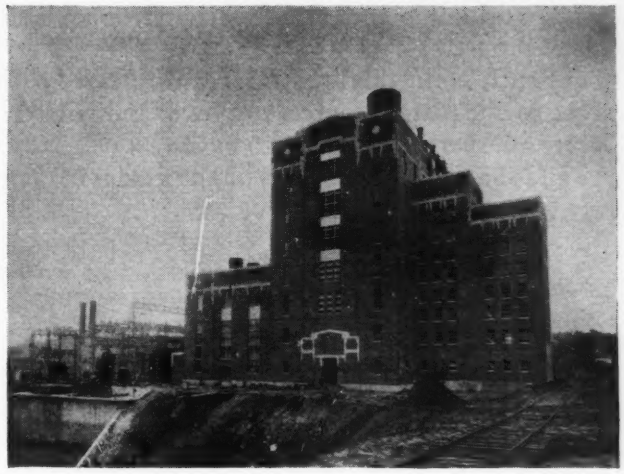
NATURAL RESOURCES

Great raw material resources have been a prime factor in the South's industrial progress. The region produces nearly all the cotton grown in the United States, has 52 per cent of the cotton spindles, manufactures 62 per cent of the cotton goods, and uses 70 per cent of the cotton. The industry is now well balanced; in addition to the coarser goods all the finer grades of cotton goods are made, bleached and dyed in Southern factories. There are 421 knitting mills, 72 woolen and worsted mills, 70 silk mills, 77 dyeing and finishing plants, and 12 rayon plants completed or under way.

Lumber and woodworking is a major Southern industry. The South has 28 per cent of the country's total timber supply and produces 47 per cent of the lumber. Paper making has made rapid strides in this section; in 1912 the South produced 20 per cent of the country's output, but in 1928 it produced 38 per cent. Nearly all the tobacco of the country is raised in this region, of which it manufactures $400,000,000 worth into finished products.

The South has been dominant as a mineral producing area, yet its resources of raw materials have scarcely been touched.

Of the country's principal domestic mineral supply, practically all of the sulphur, phosphate rock, bauxite, barite, natural asphalt, graphite and fuller's earth mined in the United States comes from the South. This section, in 1928, with another high record for petroleum produced, provided 63 per cent of the country's petroleum, or 43 per cent of the world's output; about one-half of the clay, feldspar, lead, zinc, mica, and over one-third of the country's coal. Of the more than 50 minerals mined in the South a Southern State either leads or is second in production of 38 of them.



Gorgas Steam Plant, Unit No. 4, Alabama Power Company

The South has vast resources of iron, coal and limestone in close proximity. In the Birmingham district alone, at the present rate of production, it is estimated that the iron ore reserves will last 333 years. The South has an abundance of coal, iron, oil, lead, zinc, copper, sulphur, phosphate, bauxite, feldspar, clays, limestone, marble and granites, and a variety of lesser known minerals.

In addition to the expansion in the oil and gas regions of the South and the increased production of coal (West Virginia in 1928 assumed leadership over Pennsylvania which ranked first for so many years) and the possible development of a great potash industry, there has been rapid progress in the South's ceramic development. In raw materials utilization in the building and construction industry, such as lime and the development of cement plants, as well

TABLE VIII

Southern Coke Production

STATES	1900 Tons	1910 Tons	1927 Tons	***1928 Tons
Alabama	2,110,837	3,249,027	4,364,354	4,330,000
Georgia	73,928	43,814	*	*
Kentucky	95,532	53,857	*	*
Maryland	....	....	1,077,309	1,176,000
Missouri	....	....	*	*
Tennessee	475,432	322,756	227,120	200,000
Virginia	685,156	1,493,655	316,754	*
West Virginia	2,358,499	3,803,850	1,923,427	2,178,000
Total	5,799,384	8,966,959	8,007,964	8,751,000
United States	20,533,348	41,708,810	51,092,143	52,582,000

*Included in total for South but not listed separately without disclosing output of individual companies. **Includes Virginia. ***Incomplete preliminary estimate Bureau of Mines; some Southern States not listed separately and not included in South's total.

as clay-working plants, the South has made substantial progress.

The South's minerals are strategically located with respect to adequate resources of power and labor.

Every Southern State seems to have vast reserves of clays and shale. In its reserves of fine grades of clay, including kaolins, ball clays and china clays, the Southern States stand practically alone in this country. The white sedimentary kaolins of Georgia, South Carolina and Florida probably constitute one of the South's most valuable resources. Georgia alone is said to have the largest deposits of kaolin in the world. Mississippi, Arkansas, Texas, Missouri and Alabama also have large deposits of kaolin which have not been developed. All of the white burning ball clay used is mined in Tennessee and Kentucky. There are large reserves upon which estimates of tonnage have never been made. Mississippi has large areas underlaid with ball clays, and some of these deposits have an indicated depth of 500 feet. High-grade fire clays, so necessary to the development of industry, occur in Kentucky, West Virginia, Alabama, Georgia, Missouri and Arkansas in almost limitless quantities. Shales, which are valuable for the manufacture of clay products, are also available for Portland cement in connection with the limestone and marble deposits abounding in most of the Southern States.

The center of the feldspar mining industry is in North Carolina, with Tennessee the leading grinding state.

The South is one of the country's chief producers of fine marbles and granites, Georgia, North Carolina, Alabama, Tennessee and Texas being famed for the quality of their products.

TABLE IX

Southern Iron Ore Mined

STATES	1900 Tons	1910 Tons	1927 Tons	*1928 Tons
Alabama	2,759,247	4,801,275	6,445,464	6,297,000
Georgia	**336,186	313,878	50,312	91,000
Kentucky	52,920	***64,347	....	....
Maryland	26,223	14,062	....	....
Missouri	41,366	78,341	78,605	100,000
North Carolina	....	65,278	32,528	....
Tennessee	594,171	732,247	121,914	130,000
Texas	16,881	29,535	....	....
Virginia	***921,821	***903,377	64,592	28,000
Total	4,748,815	7,002,340	6,793,415	6,464,000
United States	27,553,161	56,889,734	61,741,100	62,151,000

*Preliminary estimate. **Includes North Carolina.
***Includes West Virginia.

TABLE X

Iron Ore Reserves in Certain Southern States

STATES	Red Ore, Tons	Brown Ore, Tons
Alabama	1,000,000,000	75,000,000
Georgia	200,000,000	125,000,000
Tennessee	600,000,000	225,000,000
Virginia	50,000,000	300,000,000
Total	1,850,000,000	725,000,000

All of the country's deposits of bauxite ore, the only commercial source of the metal aluminum, are located in the South. Arkansas alone mines over 90 per cent of the output of this mineral in the United States.

In fluorspar Kentucky supplies over one-half of the shipments.

Four Southern States supply 90 per cent of the carbon black, with Louisiana producing 60 per cent of the domestic output.

Louisiana and Texas contain enormous deposits of salt. Louisiana's reserves alone of this product are estimated at 50,000,000,000 tons, with Virginia also a heavy producer.

Florida, Georgia and Texas produce practically all of the country's output of fuller's earth, Florida at present producing about half of the country's supply, and Georgia contains reserves so large that no attempts have been made to estimate them.

The accompanying tables show the resources and production in coal, iron, coke and steel.

The South has five times as much coal area as all of Europe, excluding Russia, and twice as much, including Russia.

SOUTH'S IRON ORE OUTPUT

According to the Bureau of Mines, 62,151,000 tons of iron ore were mined in the United States in 1928, an increase of 1 per cent compared with 1927. Ore

shipped that year amounted to 63,244,000 tons, valued at $154,491,000, an increase of 3 per cent in quantity and 2 per cent in value compared with 1927. About 85 per cent of the iron ore shipped came from the Lake Superior district, as compared with 83 per cent the previous year. The Southeastern States, constituting the second largest iron ore producing area, including the Birmingham and Chattanooga districts, produced approximately 6,646,000 tons in 1928. Shipments from this area amounted to 6,462,000 tons, valued at $12,784,000. Compared with 1927, production and shipment decreased 2 and 6 per cent respectively and value 8 per cent. The ore is mainly hematite, brown ore and magnetite coming next in order. There are also large deposits of gray ore in the Alabama district which authorities state offer opportunities for further development of the South's iron industry.

In 1926 the South produced 7,226,978 tons of iron ore, while the country's total output in 1926 was 67,623,000 tons.

had a minimum of 2,600,000,000 tons of red and brown iron ore of commercial grade, and this does not include the gray iron ores of Alabama nor the enormous reserves of low-grade red ores.

In 1928 the South produced more than 4,500,000 tons of pig iron, or about one-eighth of that produced in the United States.

POWER

But its resources in labor supply, in climate, in soil, in transportation and in minerals would not have produced its industrial renaissance had it not energy from fuel and water in unlimited quantities and available in almost any section at a reasonable cost.

The South's power resources include large areas of coal, lignite, oil and gas, and much developed and undeveloped water power. It has approximately 100,000 square miles of coal lands, and oil reserves in excess of 5,000,000,000 barrels. It has the largest gas field in the world, and it produces 63 per cent of

TABLE XI

Potential and Developed Southern Waterpower

STATES	Available* 90 Per Cent of Time Horsepower	Available* 50 Per Cent of Time Horsepower	Capacity Developed 1908 Horsepower	***Capacity Developed 1928 Horsepower
Alabama	472,000	1,050,000	161,694	646,423
Arkansas	200,000	300,000	5,868	15,550
District of Columbia	**	**	**	5,870
Florida	20,000	30,000	4,539	7,955
Georgia	572,000	958,000	166,587	463,453
Kentucky	172,000	280,000	14,156	142,255
Louisiana	1,000	2,000	1,184	....
Maryland	106,000	238,000	21,715	37,815
Mississippi	30,000	60,000	7,922	....
Missouri	67,000	152,000	10,107	20,560
North Carolina	852,000	1,160,000	162,284	643,768
Oklahoma	70,000	194,000	2,994	1,948
South Carolina	555,000	860,000	207,242	574,478
Tennessee	654,000	882,000	95,060	177,425
Texas	288,000	614,000	9,966	26,934
Virginia	459,000	812,000	100,123	141,471
West Virginia	355,000	980,000	20,500	91,279
Total	4,873,000	8,572,000	991,941	2,997,184
United States	38,110,000	59,166,000	5,356,680	12,296,000

*Computed January 1, 1928, by the Geological Survey. **Included with Maryland. ***Included only plants producing over 100 horsepower; those producing less are estimated to have an aggregate capacity of 900,000 horsepower in the United States.

SOUTH'S IRON ORE RESOURCES

No investigation comprehensive enough in its scope has been made to enable an accurate estimate of the quantity of iron ore in the South to be given.

However, several years ago the figures in Table X were presented by the United States Geological Survey for workable iron ore reserves above the 1000-foot level in certain Southern States.

One authority estimated in 1912 that the South

the oil supply of the United States and 43 per cent of that of the world. Lignite, once regarded as of little value as a fuel, is now regarded as having great worth for some sections of the region.

More than 60 per cent of the gain made in installed water power in the country was in the South, which now has 3,780,000 horsepower, or 28 per cent of hydro-electric generating capacity of the United States. It is estimated that over $3,000,000,000 will

be required within ten years to carry out the construction program of the power companies to keep pace with the growing demands for power.

Statistics on the water powers of the South and on the energy produced in public utility plants are given below:

No more interesting instance of reciprocal cause and effect between industry and its location could be cited than the coincident development of the South and power production. In its ever-accelerating development, the South has demanded more and more power for its new factories, for farm use and for many other purposes, and for their part the power companies not only have met this demand, but also have provided for continuing increases so that no time will be lost in supplying all needs. From plans announced by the companies in the South, no fear is entertained that the power supply will prove inadequate, and conversely the companies feel assured that they will find a market for all the new power they plan to produce. The South not only produces scores of raw materials to be manufactured into even more scores of finished articles, but also it has in abundance the power and other facilities with which to do this fabricating.

The great waterpower areas of the Southeast are closely joined to, and in some cases are overlapped by, great coal deposits; the Southwest has coal, lignite, oil and gas. As a result, much of the South now is covered with a great interconnected system of high-tension transmission lines and all parts of the territory are assured of a practically unfailing supply of power at all times, even in periods of drought. More than this, it is important to remember coal and oil and natural gas and lignite are not merely power producers, but also are basic raw materials in great chemical industries.

The development of increasingly efficient steam-electric generating units indicates that steam plants will figure prominently in future central station construction and in private plants, improvements in steam turbines, in boilers and in other details of large units having increased economy and efficiency in the operation of such systems. It is also pointed out that the steam plant equipment is more readily adapted to unit construction as the growth of the business may require; each turbine can be erected with its own battery of boilers and auxiliary equipment, and each unit can be placed in use as needed. Thus, with economical steam generating plants and ample supplies of fuel, with great hydro plants with abundance of waterpower, and with excellent labor and great raw material resources, there is no reason why the South's industrial development should not continue at an accelerated pace.

TABLE XII

Electric Power Production by Public Utilities

STATES	1927 Total Kilowatt-Hours	Total Kilowatt-Hours	1928 Total Kilowatt-Hours	By Fuels Kilowatt-Hours
Alabama	1,867,079,000	1,694,929,000	1,647,770,000	47,159,000
Arkansas	166,879,000	*146,118,000	39,783,000	106,335,000
District of Columbia	414,393,000	467,206,000	10,738,000	456,468,000
Florida	581,743,000	636,584,000	17,311,000	619,273,000
Georgia	709,664,000	979,362,000	905,262,000	74,100,000
Kentucky	566,198,000	623,970,000	285,393,000	338,577,000
Louisiana	633,018,000	821,630,000	....	821,630,000
Maryland	602,355,000	1,477,023,000	877,697,000	599,326,000
Mississippi	45,831,000	50,402,000	....	50,402,000
Missouri	958,452,000	991,404,000	75,221,000	916,183,000
North Carolina	2,086,547,000	2,245,451,000	1,989,662,000	255,789,000
Oklahoma	676,019,000	839,221,000	4,317,000	834,904,000
South Carolina	1,116,852,000	1,432,969,000	1,298,537,000	134,432,000
Tennessee	928,592,000	956,681,000	707,285,000	249,396,000
Texas	1,839,466,000	2,219,725,000	9,037,000	2,210,688,000
Virginia	1,088,601,000	1,168,500,000	314,645,000	853,855,000
West Virginia	2,047,629,000	2,044,429,000	172,813,000	1,871,616,000
Total	16,329,318,000	18,795,604,000	8,355,471,000	10,440,133,000
United States	80,205,474,000	87,892,468,000	34,755,812,000	53,136,656,000

*The decrease in production compared with 1927 would indicate that Arkansas is using less electricity, but such is not the case, since a large part of the output of the Sterlington (La.) plant of the Louisiana Power & Light Company is being taken by the Arkansas Power & Light Company for distribution in Arkansas.

Principles *of* Automatic Control *for* Steam Boilers

By T. A. Peebles
Vice-President, Hagan Corporation, Pittsburgh, Pa.

In order to effect an efficient mechanical control of boilers, the underlying principles employed should be thoroughly understood. Mr. Peebles has developed these principles, beginning with a simple hand fired installation and leading up to a complicated coal and gas fired combination.

COMBUSTION control equipment finds its place in all types and sizes of present day boiler plants. The type of control that would be found in a small isolated plant bears little resemblance to the comprehensive system employed in the large central station or industrial plant, but in each case it is designed to accomplish practically the same result. Such equipment is not intended to replace the services of a competent operator but rather to make his work more effective, by doing mechanically those things that are best done by mechanical means. This consists in simultaneous and proportionate variations in fuel and air supply in accordance with load changes, and involves the operations of changing damper positions, fan speeds and rate of fuel feed, to keep these variables in proper relation to load conditions.

The accomplishment of these things is essential to the attainment of best results and is secured more satisfactorily by mechanical means than by manual control. All such adjustments can be made by control mechanism with such accuracy that the skilled operator could be dispensed with entirely if it were not for the nature of the variable factors encountered. Equipment for this purpose has been developed by a number of manufacturers until it is the equal of automatic control equipment in the electrical field; but due to the nature of the equipment it controls, the skillful operator, while relieved of the greater part of the work he would otherwise be required to do, is still required.

The simplest application of combustion control equipment is to the natural draft, hand fired boiler plant. This application involves only the use of a draft controller which will adjust the draft in accordance with the varying load conditions. It remains for the operator to supply sufficient fuel to meet the load requirements and to keep the fuel bed in such condition that air drawn through the grate will be brought into contact with burning fuel and not allowed to find its way into the furnace through bare spots or accumulations of ashes. Even this simple application of combustion control equipment often produces surprising results. In plants of such simple construction, instruments which would indicate to the firemen the results being secured are almost entirely lacking and in the few cases where they are used they are often not understood. In such plants it is usually customary to open the dampers wide when boilers are put on the line and close them when the boilers are shut down, with no adjustments during the period of operation. The result is that the air flow through the furnaces is always equal to that required to carry the maximum load of which the boilers are capable. The pressure variations which occur with load changes are taken care of by shoveling more or less coal and the result is that during periods of average load the efficiency is very low. Plants of this kind burning only a few tons of coal per day could not justify even the installation of a draft controller unless large fuel savings could be made, but large savings are possible due to the low efficiency and often run as high as 20 per cent to 30 per cent of the fuel previously burned.

Where the plant is of such size that something more than the hand fired furnace is necessary or desirable, the natural draft mechanical stoker is installed. This introduces one additional element of control since the feed of the stoker must now be regulated to provide a supply of fuel in accordance with the load. An installation of this kind introduces the requirement for automatically proportioning fuel and air. In such installations a number of stokers are often driven by one engine or motor which can be regulated in accordance with the plant load. In addition, the stokers are provided with individual adjustments by which the rate of fuel feed can be regulated independently of the speed of the stoker driving engine or motor, but the adjustments are usually in such large steps that they do not lend themselves to automatic control. It is now generally recognized that the most satisfactory automatic control for such a plant consists in equipment that will automatically control the draft and fuel feed in accordance with the load while the individual stoker adjustments are left to the care of the operator.

In plants where it has been the practice to leave all dampers wide open when boilers are in operation and to control the steam pressure by regulating the adjustment of the stokers, savings as high as 25 per cent of the previous coal consumption have resulted, although such cases are somewhat unusual, the average saving being somewhere between 5 per cent and 10 per cent.

The application of forced draft to mechanical stoker introduces additional factors that must be considered. The fuel beds are usually of increased thickness and the combustion rates are higher than those commonly employed with natural draft stokers. Both these factors combine to increase the fuel bed resistance and require additional means for control of the air supply that will be independent of fuel bed resistance. Furthermore, forced draft stokers are usually individually driven and each boiler therefore becomes an independent unit so far as its control is concerned. It is desirable, however, that each individual unit should carry its proper share of the plant load.

The capacity-efficiency curve of a steam generating unit is not flat and the best results are secured only when the boilers are operated within certain limits of rating. It is natural therefore to place in service that number of boilers which will most economically carry the expected load and then divide this load equally among these boilers. It is essential that they all respond equally to control system impulses which are set up by variations in load.

If two boilers fired by forced draft stokers are operated with fans running at the same speed, or with the same pressure of air in the wind box of each unit, they will not operate at equal rating. Differences in fuel bed resistence, influenced by size and moisture content of the coal, will produce quite different rates of combustion with equal wind box pressures and other means must be adopted to insure more uniform distribution of the load. The draft loss across two boilers of similar construction, while not exactly the same, will correspond much more closely than the pressure drop across two fuel beds; and by maintaining an equal draft loss across two boilers, or by running their induced draft fans at the same speed, they can be maintained at the same rating within sufficiently close limits for all practical purposes. The control impulse set up by a master controller in response to load variations can therefore be best employed to control the escape of gases from the boiler.

The fuel feed may be controlled directly from the master control or it may be controlled indirectly in accordance with the draft loss across the boiler. Either of these arrangements will give only approximate regulation of fuel. In the first place, there is no definite relation between the gas weight and draft loss which follows a sufficiently regular curve to permit an accurate measure of air flow. Any regulation of the stoker speed in relation to the draft loss across the boiler, will therefore not maintain a definite relation between air flow and stoker speed.

In the second place, if the relation of air flow of stoker speed could be maintained correctly it would not insure proper relation between air flow and fuel supply, because the fuel is subject to a change in heating value and the stoker is not a coal meter. Changes in fineness and moisture content of coal will change the weight of coal supplied for a given stoker speed by as much as 10 per cent and this discrepancy, in addition to the varying heat content, will affect the accuracy of proportioning, regardless of the accuracy with which the control equipment may operate.

To meet this condition provisions must be made by which manual adjustment of stoker speed may be made from time to time as indicating instruments or the conditions of the fire may show to be necessary. Final control of the air supplied for combustion may be secured in accordance with combustion chamber draft. If this equipment is adjusted to maintain a predetermined furnace draft, and there is any departure from this value for a fixed position of the boiler damper or speed of induced draft fan, it indicates a change in air flow brought about by a change in fuel bed resistence. If this resistence should increase, the weight of gas passing through the boiler will be decreased, and the furnace draft will tend to increase. The draft controller actuated by this increase will re-adjust the undergrate damper to increase the wind box pressure until it has been built up to that amount required to force the right amount of air through the fuel bed. On the other hand, a decrease in fuel bed resistence would result in an increased flow of air and a reduction of furnace draft, which is corrected by a partial closing of the undergrate damper and a consequent reduction in the wind box pressure.

With an arrangement of this kind the operator is not concerned with adjustments rendered necessary by changes in load or varying draft conditions, and he may devote his entire attention to combustion conditions and the manual adjustments of fuel feed necessary to maintain these conditions. His duties are practically identical to those of the test engineer when operating a boiler regardless of plant load, in order to determine the best possible efficiency.

It may be necessary from time to time to operate one or more boilers at a rating different from the average of all the boilers, and for this purpose manual adjustment of the rating is desirable. Adjustments intended for this purpose, as well as adjustments for manual control of fuel supply, are preferably grouped on a panel near the boiler for the convenience of the operator.

In the control of powdered fuel a variety of arrangements may be employed, depending upon the manner in which the fuel and air are delivered to the furnace. The absence of a fuel bed, with its varying resistence and large storage of burning fuel, alters the situation considerably. Since there is no reserve supply of fuel in the powdered fuel furnace, the momentary rates of fuel and air supply must bear the proper relation to one another if the best of results are to be secured.

It is possible to secure high efficiency of combustion on a stoker fired furnace under conditions which

would give very poor efficiency with powdered fuel. A stoker might be operated at a continuous rate, required to meet an average load, with variations of considerable amounts above and below this average. If these variations were of short duration it would be possible, by regulating the air supply in accordance with the load and supplying fuel at a steady rate equal to the average load, to secure entirely satisfactory conditions. This is impossible with powdered coal where there is a very small amount of fuel actually undergoing the process of combustion at any one time. To offset this condition, however, there is no varying fuel bed resistence to contend with, and if the burners are properly designed there is no difficulty in securing proper intermingling of fuel and air. If the proper fuel and air proportions are supplied to the furnace, efficient conditions of combustion will exist; while in the case of stoker firing it is possible that due to irregularities in the fuel bed, the air introduced will not be brought into contact with burning fuel. The control of powdered coal therefore becomes primarily a problem of proportioning fuel and air.

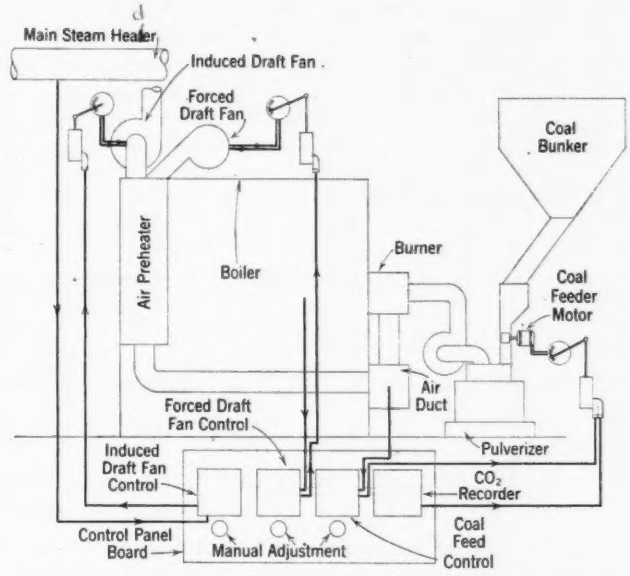


Fig. 1—Diagramatic control system for pulverized coal fired boiler, with forced and induced draft fans

An arrangement that accomplishes this result is illustrated in Fig. 1. Variations in load demand, actuate the induced draft fan controller which adjusts the speed of the induced draft fan. Variations in the speed of this fan affect the furnace draft which in turn actuates the forced draft controller to produce the change in forced draft fan speed necessary to reestablish the predetermined draft in the combustion chamber. The change of forced draft fan speed affects the pressure of air delivered to the forced draft duct through which the air is distributed to the powdered fuel burners and the pressure of air in this duct is a measure of the volume of air being delivered to the burner. This pressure in turn is used to control the fuel feed regulator, producing adjustments of the fuel feeder or the speed of its drive in accordance with the quantity of air entering the burner.

This arrangement provides safety of operation and automatically prevents the delivery of powdered fuel to the furnace in case of failure of the air supply. If the induced draft fan should fail there would immediately be a decrease in furnace draft and in response to this change the forced draft controller would slow down the forced draft fan in order to prevent the building up of a pressure in the combustion chamber. As the forced draft fan speed is reduced, the pressure in the air distributing duct will be rapidly reduced, which in turn will cut down, and eventually completely cut off, the coal supply. If the forced draft fan should fail the coal supply will immediately be cut off but the induced draft fan might continue to operate. There would be no element of danger in this operation however, as any unburned gases remaining in the combustion chamber would be immediately withdrawn.

While this arrangement will accurately proportion the speed or the adjustment of the coal feeder in accordance with the air supply, it does not take account of variations in feeder characteristics nor does it take account of variations in the heating value of the coal. When the local conditions are such that these factors are subject to considerable variation, secondary adjustment of fuel supply may be effected in accordance with the composition of the escaping gases. For this purpose a continuous automatic gas analyzing apparatus is employed to actuate a relay which in turn controls the secondary adjustment of fuel supply. So long as the CO_2 content of the escaping gases remains within predetermined limits, the control is not affected by this corrective device; but, upon a departure of the CO_2 from the desired value, adjustments of the fuel supply are automatically corrected for whatever variations may have occurred, either in the heating value of the coal or to the action of the feeding mechanism.

Powdered fuel firing is now being used in combination with blast furnace gas or other bi-product fuels and the advantages of this combination are so great that its use may be expected to increase rapidly. The principal application will be a combination of blast furnace gas and powdered coal, where the powdered coal acts as an auxiliary fuel. Since there is no definite relation between the load on a steel mill power station and the quantity of blast furnace gas available, the rate of auxiliary fuel supply in such applications is subject to wide fluctuations. A control equipment similar to that illustrated in Fig. 2, meets all the requirements of combination firing and produces an extremely flexible unit easily capable of handling all load variations. The control is divided into the following steps.

1. The supply of blast furnace gas is regulated in accordance with the steam demand. During periods of low demand it is more economical to allow ex-

cess gas to escape through bleeders than to be burned under the boilers and allow steam to escape through the safety valves.

2. The gas burners are so designed that the proper air and gas proportions are secured when the pressure of air delivered to the gas burner is equal to the pressure of gas. This condition is maintained by the use of a balanced float controller, one float of which is responsive to gas pressure and the other to air pressure. The controller maintains this balance by adjusting the damper in the air duct leading to the burner.

3. Since blast furnace gas is used for other purposes around the plant where no auxiliary fuel is available, it is not permissible that the boilers be allowed to take sufficient gas to reduce the supply below the predetermined minimum. In case the demand for gas should be so large as to reduce the pressure in the gas main below this minimum, a second controller responsive to gas pressure automatically cuts out the controller which regulates gas supply in accordance with the load on the boilers and regulates to permit only that quantity of gas to go to the boilers which can be supplied without reducing the pressure in the main below a predetermined point.

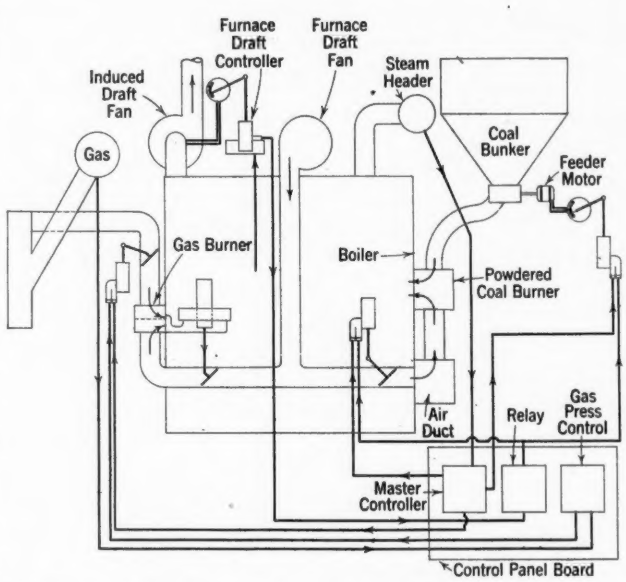


Fig. 2—Control system for combination firing with both blast furnace gas and pulverized fuel

4. When the gas supply is sufficient to meet the load demand there will be a drop in steam pressure and powdered coal is automatically cut in. The quantity of powdered coal increases progressively with further reduction of steam pressure until it has been brought up to a sufficient amount to meet the existing steam demand.

5. A combination fired unit is designed to develop a certain maximum rating when burning blast furnace gas and probably the same or a slightly higher rating when burning powdered fuel. During periods of low gas supply powdered fuel may be delivered to one or more boilers up to the maximum amount for which the equipment is designed. If the gas supply should suddenly be re-established it will find its way directly to the boilers because the steam pressure will be low and consequently the valves in the gas line controlled by steam pressure will be wide open. When the gas supply is deficient this control valve is closed due to low gas pressure, but when the gas pressure is again re-established the gas pressure controller will allow this damper to open. This large supply of blast furnace gas with its air for combustion would result in the building up of a high pressure in the combustion chamber at times when a large quantity of powdered coal is also being burned. To prevent this condition the furnace draft controller which adjusts the speed of the induced draft fan is interlocked with the powdered fuel control. When the condition just described occurs the draft controller brings the induced draft fan up to full speed and then cuts out the powdered fuel control from steam pressure and regulates to permit only that amount of powdered fuel to enter the furnace which can be burned in addition to the existing supply of blast furnace gas without building up a pressure in the furnace.

This arrangement provides that at all times the full amount of blast furnace gas available will be burned and that whenever a deficiency exists pulverized fuel will be introduced in that quantity required to make up for the deficiency. As soon as additional blast furnace gas is available, the powdered fuel is automatically cut off so that only the minimum amount of powdered fuel required to make up for a gas deficiency is burned. This arrangement does away with the necessity for having standby boilers which operate at very low efficiency on account of their low load factor and the control system renders the equipment much more flexible in handling load variations than the older arrangement of separate boilers for burning blasts furnace gas and auxiliary fuel.

In all applications of combustion control it is important that fans and fuel feeding devices be arranged so that the functions of the control equipment can be properly carried out. Fans are sometimes selected with the sole object in mind of securing the highest motor efficiency and the drive selected increases the cost and complications of the control. In some cases stoker drives having only four or five speeds are selected. It is obviously impossible to operate a boiler over a wide range of capacity and to get anything approximating the correct fuel feed for the given rating, if the stoker can be run at only four or five different speeds and no other suitable means are available for adjusting the rate of fuel feed. Consideration should always be given to the control equipment before these details relating to the auxiliary equipment have been definitely settled.

Sulphur *in* Flue Gases

A New Problem in Power Station Practice

By David Brownlie, London

DURING the past few years black smoke troubles in connection with power station chimneys have practically ceased to exist with any reasonably good condition of plant operation and method of control. This is true alike for mechanical stoking and pulverized fuel firing. The question of grit and dust is another matter, but even in this case there is, on the average, nothing particular to complain about. A number of stations are making every effort, regardless of expense, to insure absolutely clean chimney tops.

The movement in centers of population throughout the world toward higher standards of sanitation, is beginning to make itself felt with respect to our larger coal burning plants. This movement is one to which power generating stations must submit, sooner or later. As in all such movements, the ultimate cost must be borne, directly or indirectly, by the people that are benefited, even though the burden may have to be carried initially by the power plants themselves.

Now, however, a new problem has suddenly developed—that of the acid gases caused by the combustion of sulphur in the coal or other fuel and discharged from the chimney along with the CO_2, excess oxygen, residual nitrogen, and perhaps traces of CO, the combination of them all constituting the normal products of combustion.

This new problem has arisen in Great Britain because of an action for injunction, first brought on the 16th and 17th July 1928, at the Manchester Assizes, by Mr. Arthur Farnworth, a farmer of Barton, against the Manchester Corporation in regard to alleged damage to his crops caused by the chimney gases from the Barton Electricity Station, one of the main power plants of the Corporation of Manchester, which it may be stated is outside the City area.

The gist of the Plaintiff's case against the Corporation was that the coal consumed at Barton varied from 550 to 560 tons per day, corresponding to about 11 tons of sulphur discharged into the air per day from 12 chimneys, which left the top of the chimneys at a velocity of only about 14 feet per second instead of the normal rate of 30 to 40 feet. Consequently it was stated that when the wind was light and in the North-East, a sufficient part of the gases was blown down along the ground and on to the crops, so as to produce disastrous effects on the vegetation, as rendered evident to the eye. This case was backed up by the Farmers' Union of Great Britain, and it was stated that trouble had been caused to vegetation in this way since 1924.

The line of defense adopted by the Manchester Corporation was that it was not possible to generate electricity by burning coal without sending sulphur dioxide into the air, and that the erection of chimneys 30 or 40 feet higher, for example, would make little difference in the net result.

This first case was won by the Corporation, the farmers being refused an injunction, but subsequently it was taken by the Farmers' Union to the Court of Appeal, being heard on the 13th, 14th, 15th, and 16th November 1928, and the 13th December 1928. On this last occasion the Farmers' Union won, an injunction to stop the nuisance being granted against the Corporation. Incidentally, the Judges said in this connection that the Manchester Corporation did not seem to have considered what would be the effect of a very large quantity of sulphur fumes given off from the site. However, the Manchester Corporation have now taken the case to the final Appeal Court of the British Empire, that is the House of Lords, where it is still under consideration.

Further, during the past few months there has been a great uproar in London against the erection by the London Power Company of a new power station at Battersea on the Thames, which it is stated will eventually have a consumption of 2000 tons of coal per 24 hours, and will cost £6,000,000. Strong opposition to this project, for which, however, permission has been granted by the Electricity Commissioners, has been forthcoming from many different sections of the community, including not only power station engineers, fuel experts and the Coal Smoke Abatement Society, but also artists, architects, the Westminster City Council, the Chelsea Borough Council, the London County Council, and the Authorities responsible for the Tate Art Gallery, Kew Gardens and many other places, and incidentally the Archbishop of Canterbury.

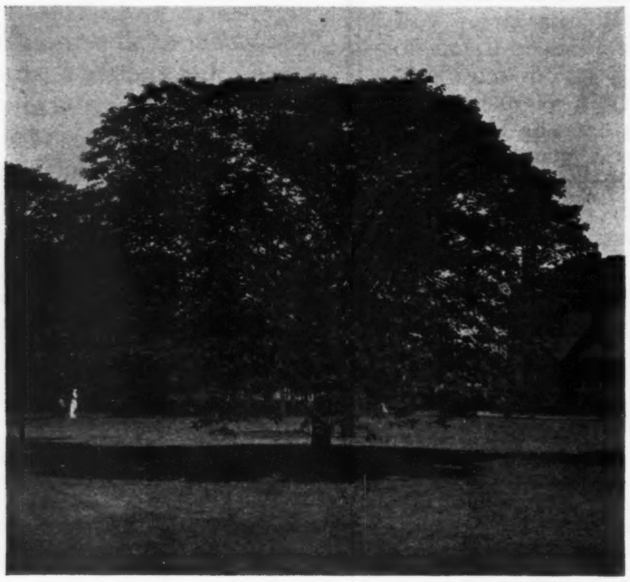
Here, therefore, we have the present position in a nutshell, and there is no question but that this problem of sulphurous and sulphuric acid in combustion gases will arise sooner or later in connection with almost every power station in the world. In London, of course, just as in New York or any other metropolitan center, the matter is obviously serious when a power station is placed in the middle of a town with millions of inhabitants. Greater London, for instance, represents nearly 8,000,000 people, and it is contended most strongly that this station has no right whatever to be erected in the middle of London, but should be installed lower down the

Thames Estuary, on the same lines as Barking Station.

Until this trouble commenced at Manchester no one, not even the most fanatical anti-black smoke man, had given a thought from the practical point of view to the question of sulphurous and sulphuric acid gases, which are, of course, invisible. Also it should be emphasized that the matter has come to a head because of the enormously increasing size of the modern super-power station. It is not very many years ago that even the largest installation burned only 200 or 300 tons of coal per 24 hours, but now we have plants with a consumption of 2000 or 3000 tons per 24 hours, while over 5000 tons is an almost immediate possibility, especially as we are in the case of the power station is this concentration of the emission of acid laden gases.

Quite apart from its action on the outside of buildings, and its action within buildings on curtains, wall-paper, pictures and other furnishings, the effect of this acid-laden gas on vegetation is of course disastrous. The matter is particularly difficult in the City, because London possesses so many magnificent open spaces and large parks, as well as gardens, some of which, such as Kew Gardens and Hampton Court, are among the most famous in the world.

Obviously, therefore, the final decision of the House of Lords will be awaited with very keen interest indeed, although it has been decided—in spite of the great public opposition—that the first section



Photographs by courtesy of Stevens Institute of Technology

Trees at Stevens Institute, Hoboken, N. J., showing mulberry trees at left unaffected, and maple trees at right affected by atmospheric contamination

given to understand that in the United States there are several power stations designed for 1,000,000 kw. ultimate capacity.

Taking simple figures, for the sake of argument, we can assume that so far as Great Britain is concerned, the average sulphur content in coal is 1.5 per cent. In the case of a station such as is proposed at Battersea the estimated coal consumption would indicate a discharge of 30 tons of sulphur, or 90 tons calculated as sulphuric acid, per 24 hours. It would be a very large chemical works indeed that would manufacture 90 tons of sulphuric acid in this period, and of course the figures in connection with a station of say 5000 tons of coal per day, and perhaps more than 1.5 per cent sulphur in the coal, are still more staggering.

Incidentally, in relation to Battersea, the figure of 2000 tons of coal per day is equivalent, within one small area, to the whole of the sulphur gases discharged from the fires of about 125,000 private houses; that is to say, a huge town of nearly half a million inhabitants, and one of the great difficulties of the Battersea Power Station is to be erected, which seems from the point of view of the interests of electricity in general, to be a somewhat misguided proceeding.

At the same time, it must be admitted that the whole subject is extremely difficult and complicated, and it is by no means clear what is the best method to adopt in order to eliminate or reduce the trouble. Although much further research work is needed in the matter, it is generally assumed that all the organic or volatile sulphur in coal burns to sulphur dioxide (SO_2) or sulphur trioxide (SO_3), which with the moisture present form respectively sulphurous acid (H_2SO_3) and sulphuric acid (H_2SO_4). Apparently also a considerable proportion of the "fixed" or inorganic sulphur is gasified in the same way because of the intense heat of the furnace, although part of the sulphur is still to be found in the ash and clinker.

One obvious method for getting rid of sulphurous and sulphuric acid in flue gases would be washing with forced sprays of water or very dilute alkalis,

such as lime water, but the difficulty lies naturally in the enormous size of the plant that would be necessary to deal with the vast volume of combustion gases emitted from a power station burning even the moderate quantity of 1000 tons of coal per 24 hours. It is well known, of course, that a large proportion of the total sulphur in most coals is in the form of iron pyrites, and to a lesser extent other inorganic compounds containing sulphur, and one possibility is to use only coal that has been thoroughly washed so as to reduce the ash content from say 15 to 25 per cent down to 4 to 6 per cent, in which case a large proportion of the pyrites would be eliminated. This, however, is only a partial remedy, and there is always the possibility that washing some coals might actually increase the sulphur trouble; that is, a coal containing a high proportion of "volatile" or organic sulphur would be still worse in this respect if the ash content was reduced from say 20 per cent to 5 per cent.

Photo by Ewing Galloway

Typical industrial scene showing familiar haze that is produced by factory chimneys

It would seem to the author that a valuable principle, at any rate as a palliative if not a complete solution, would be to make a systematic examination of all the different coals available for steam generation, under commercial conditions, in London, New York or other metropolitanarea under consideration, with a view to finding those coals which have a low sulphur content. Nothing is more astonishing in considering this question than the enormous variation in the amount of sulphur present in bituminous and semi-bituminous coals. Thus, for example, in Great Britain it is possible to find anything from about 0.1 per cent to 6.0 per cent total sulphur, and according to published information on the subject the degree of variation is even greater in the United States, where cases are known of coals containing actually 8.0 per cent total sulphur. Very roughly, however, the total sulphur content of coal used for steam generation in Great Britain varies from 1 to 2 per cent. Incidentally, much more information is required everywhere concerning the relative amounts of fixed and volatile sulphur in available coals.

In connection with this sulphur problem reference is recommended to a highly interesting publication in the United States, the University of Illinois Bulletin No. 125, "Distribution of the Forms of Sulphur in the Coal Bed," by H. F. Yancey and T. Fraser (1921), a Report prepared under the co-operative efforts of the U. S. Bureau of Mines, the Engineering Experiment Station of the University of Illinois, and the Illinois State Geological Survey Division. The gist of these investigations is to emphasize the extreme irregularity of the distribution of iron pyrites throughout coal in the bed, whereas the organic sulphur, as might be expected, is uniform. Yancey and Fraser are of the opinion that there is little evidence of any definite relation in the occurrence of organic and pyritic sulphur, that is, a high percentage of pyrites in any given portion of the bed does not necessarily mean that there is a correspondingly high organic sulphur content. They also point out that in many coals the amount of organic sulphur is much greater in proportion to the inorganic sulphur than has been generally recognized; for example, in the case of three different coal beds, with a total number of 104 samples taken at the face, the organic sulphur exceeded the pyritic sulphur in 49 cases. The issue, therefore, as regards the reduction of the sulphurous and sulphuric acid content of chimney gases by first washing the coal is somewhat complicated.

The authors also give a table showing the total sulphur content in various American coals, but in this case the range varies only from 0.55 to 4.87 per cent total sulphur. Thus, for example, from the Mine of the White Company in Tennessee the figure is 4.87 per cent total sulphur, of which 3.59 per cent is pyritic sulphur and 1.17 per cent organic sulphur, the latter therefore being only 24 per cent of the total. As regards the lowest sulphur content coal mentioned, that from the McDowell Company of Western Virginia, and known as "Pocohontas No. 3 Bed," the total is 0.55 per cent, of which only 0.08 per cent is pyritic and 0.46 per cent organic sulphur; that is, no less than 83.7 per cent of the latter. Also in these figures the percentage of organic sulphur as compared with the total sulphur varies from 20.4 per cent to 83.7 per cent, and as already indicated, the range of total sulphur content in American and British coals is much greater than represented by the particular Table given in Illinois Bulletin No. 125, which only relates to ten coals.

Here, therefore, is an interesting problem for the power station world and also another striking indication of the fact that today the generation of electricity is a complicated undertaking in which there is represented not only the electrical, mechanical and civil engineer, but also the chemical engineer, the technical chemist, the physicist, and perhaps a few other branches of technology.

Some of the Industrial Uses to Which Powdered Coal is Being Applied

By H. W. Brooks

Consulting Engineer, New York

We are presenting an interesting digest of the important paper on this subject, prepared by the Market Research Institute of the National Coal Association, under the editorship of H. W. Brooks, who was assisted by John E. Muhlfeld, Henry Kreisinger, C. J. Jefferson, H. G. Barnhurst, W. O. Renkin, F. R. Corwin and W. C. Heckeroth.

WITHIN the lifetime of the present generation more has been learned in the field of combustion technology than in all preceding ages. While acquiring this knowledge we have converted our mode of life from one based on manual labor, in which, in its most advanced stages under the Caesars, 12,000,000 human slaves served 5,000,000 free citizens (2.4 per capita), into an industrial civilization of today, in which every man, woman and child now living in the United States is master of 150 mechanical slaves.

The idea of burning coal as a fluid instead of as a solid has long intrigued the imagination of engineers. Niepce in 1809, contemplated burning coal in the powdered form but his experiments were not successful. Between 1831 and 1856 various engineers in England and in Germany experimented with powdered coal firing in a great variety of industrial furnaces. Between 1866 and 1868 there were further developments of the art in both Europe and America, meeting with varying degrees of success.

In 1895 Hurry and Seaman, at the works of the Atlas Portland Cement Company, proved so conclusively that powdered fuel could be used as effectively and much more economically than fuel oil for cement kilns that within a decade more cement was fired with coal than with oil. Within twenty years 75 per cent of all cement manufactured was thus fired.

Since that time the development of powdered coal has been very rapid. The figures in Table I indicate the extent of powdered coal usage in the United States for the year 1919 compared with the estimated usage in 1929.

TABLE I

	1919		1929	
	Tons	Per Cent	Tons	Per Cent
Generation of Power	200,000	1.8	25,000,000	61.0
Manufacture of Portland Cement	6,000,000	54.6	8,000,000	19.5
Iron and Steel Industry	2,000,000	18.2	3,000,000	7.3
Production of Copper and Other Non-Ferrous Metals	1,500,000	13.6	3,000,000	7.3
Other Purposes	1,300,000	11.8	2,000,000	4.9
Total	11,000,000	100.0	41,000,000	100.0

It should be noted, however, that this 1929 total is but 8.2 per cent of the total American production, so that much yet remains to be done to secure the maximum benefit of this comparatively new method for burning coal. Besides those in the United States and Canada, there are now powdered coal installations in Great Britain, Ireland, Belgium, Holland, Italy, Germany, Australia, Africa, China, Japan, Malay States, Argentina, Colombia, Cuba, Chili and on the high seas. It is probable that the world total use of powdered coal during the past year approximated 55,000,000 tons.

The powdered coal method was the first and most obvious of the attempts of man to burn coal mechanically. A century of research was necessary before the method attained not only the technical perfection but more particularly the "dollar" efficiency essential to commercial success. It is not the complete technical and economic panacea for all the ills of the combustion arts, but it is a coal burning method of established value and future promise.

The trends of the past year, which appear most clearly marked in all applications are:

1. The growing popularity of unit pulverizers even on applications of largest fuel requirements.
2. Increasing realization of the essentialness of fine grinding for best results.
3. Decreasing equipment and installation costs per unit output and consequent reduction of fixed charges.
4. Horizontal turbulent burners almost universally recommended for bituminous coal.
5. Development of cheaper and more efficient methods of separation of ash from chimney gases.
6. Water-cooled walls rapidly becoming standard in boiler practice even in the medium sizes.
7. Air, preheated by waste heat (sometimes as high as 600 deg. fahr.), for drying raw coal in feeders and pulverizers and for increasing temperatures within the furnace, is generally being specified.
8. Automatic controls are becoming less costly and more dependable.
9. Slagging type furnaces for low fusion ash

coals are attaining rapid popularity—two additional installations following the pioneer at Buffalo—still another at Toronto, Ohio, and the latest now under contract for Hell Gate Station, New York, for firing the largest boiler ever built with unit mills.

10. Portable truck mounting of pulverizers has been employed with success to reduce costs where operating cycles permit.

Three substantially new pulverizers have been introduced to the market and one new complete

Battery of powdered coal feeders, Trinidad Station, Texas Power and Light Company

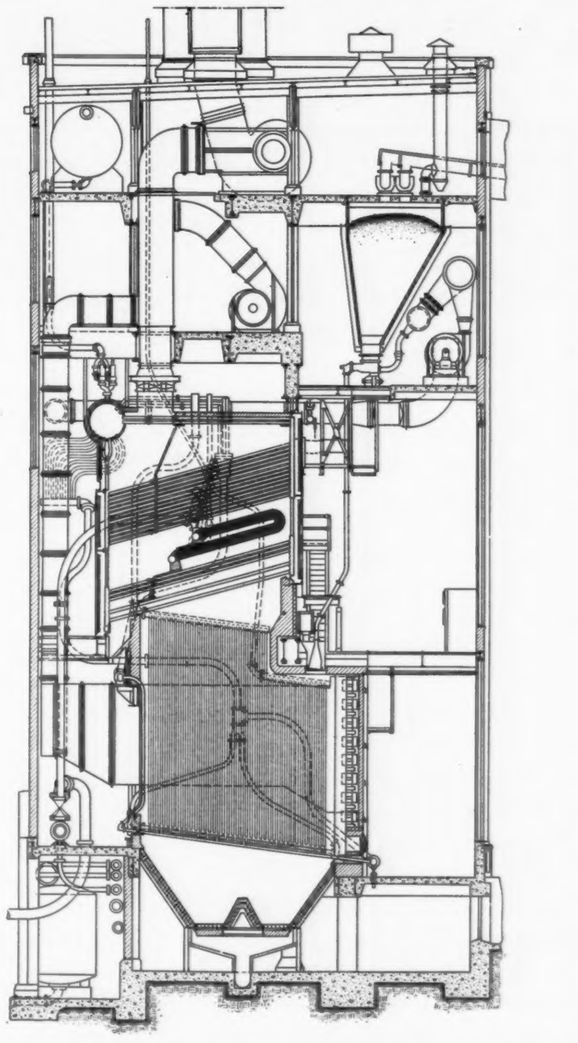
system incorporating certain features of both the unit and central systems. Increasing dependability and durability of wearing parts, simplicity of renewal and decreased power consumption, have been the ideals sought in mill design.

The first open-air, powdered-coal-fired boiler plant was installed by a sugar and railway company in Cuba.

Increased duties are the order of the day. In boiler ratings, 300 per cent is a usual present-day specification, while 600 to 800 per cent has been accomplished with success. Research indicates that ratings of 1,500 per cent are not at all unthinkable where distilled water is used.

Changes of furnace design, with more effective heating from pulverized fuel, have served to increase production enormously in metallurgical furnaces. New successes in firing open-hearth furnaces are reported—one plant using all cold metal reporting as low as 540 lb. of 12,800 B.t.u. coal per gross ton of ingots produced. The second installation of powdered coal to burn clay products has been reported from Louisiana. The first in Ohio burning common brick in a continuous car tunnel kiln used as low as 288 lb. of coal per thousand brick—probably a world's record for low-cost production. The Louisiana installation burning common brick showed important economies over oil firing at normal fuel oil prices. In both instances a dense hard brick of satisfactory color and with a minimum of culls and salmons resulted.

The powdered coal installation at the Oneida Street Station at Milwaukee, which may be considered as the pioneer commercial installation, demonstrated both the practical value of this method of firing and also the necessity for certain improvements in the construction of the furnace. Water-cooled tubes were placed over the furnace bottom to cool the ash deposited at the bottom and to reduce the furnace temperature in general. The walls of the furnace were made hollow and cooled by drawing the air used for combustion through them. The first furnaces of the New Lakeside Station at Milwaukee were built with these improvements. Although the air-cooled furnace walls showed lower maintenance and longer life, the practical rates of combustion



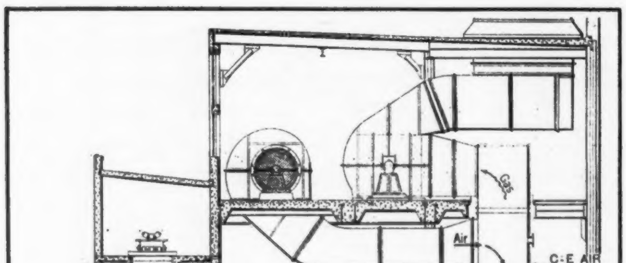
Typical installation of storage system for burning powdered coal

were still limited to about 1½ lb. of coal per cubic foot of combustion space.

The introduction of water-cooled tubes into the furnace for the protection of the furnace bottom was very promising, and therefore in the next few installations the water-cooled surfaces were extended

to protect the rear walls which suffered most from the abrasion by molten slag. These installations gave so much more satisfactory results that on subsequent large installations the side walls of the furnaces were also protected with water-cooled tubes. Thus a water-cooled furnace was developed that could be applied to any design of boiler.

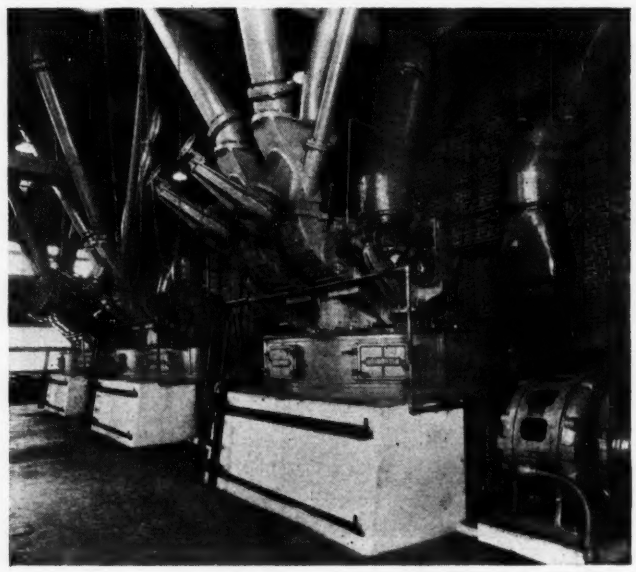
Still later, water-cooled furnaces were designed and built, consisting of water-cooled walls which were self-sustaining and did not require any brick wall back of them. Thus, after many years of development, the furnace design gradually returned to the principle with which Bettington started in 1906. The real progress lay in the fact that the newly developed water-cooled furnaces were applicable to all existing designs of boilers and were adaptable to high pressures now coming into use. With the completely water-cooled furnace the rate of combustion can be carried to 2½ lb. and even to 3 lb. of the average steaming coal per cubic foot of combustion space per hour.



Modern high pressure steam boiler fired with powdered coal

It has been amply demonstrated that all kinds of coal ranging from anthracite to lignite can be burned in pulverized form with very good results. The lignites are particularly well adapted to this method of burning. They are easily pulverized and burn very freely. Their high moisture content is no hindrance either to pulverizing or burning. They can be pulverized and burned with moisture content as high as 28 per cent, so that comparatively little drying needs to be done.

The degree to which a coal must be dried in order to be successfully pulverized and burned depends on the kind of coal. In general, anthracite must be



One of the largest coal pulverizers ever built, having a capacity of 60,000 lb. per hour

dried to 1 or 2 per cent moisture, Pocahontas and New River 2 or 3 per cent, Pittsburgh coal 3 or 4 per cent, Illinois coal 6 to 10 per cent, Western sub-bituminous 12 to 18 per cent, and lignites 25 to 30 per cent.

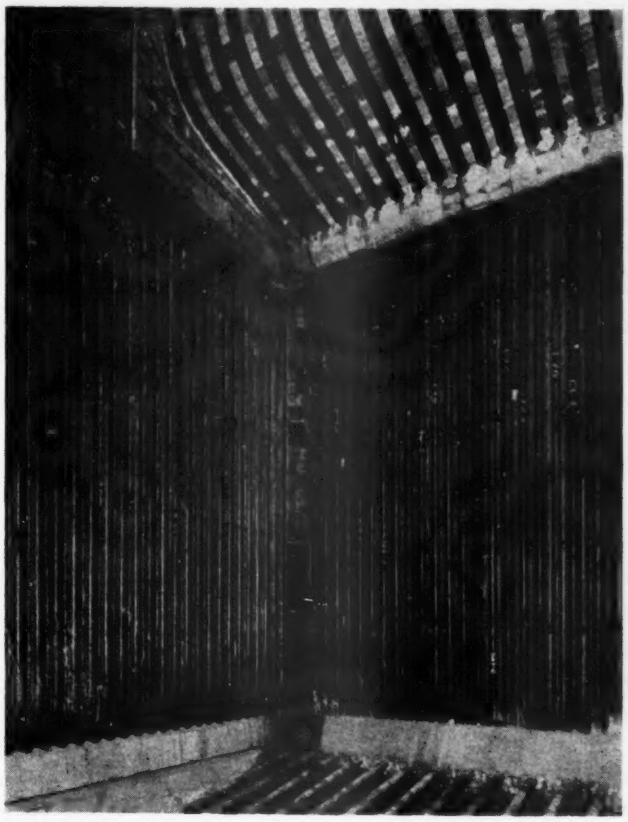
Generally speaking, the smaller sizes of coal are preferable if they do not contain excessive amounts of moisture that would require more than the usual amount of drying. At present there is a decided tendency to do away with driers and do what drying is necessary in the mill while the coal is being pulverized. Heated air is supplied to the mill for drying the coal. The supply of heated air to mill increases the rate of pulverization and improves the combustion.

There are today about 165 cement plants in operation in the United States producing Portland cement by the rotary kiln process. At least 120 of these are using pulverized coal for firing their rotary kilns, the others using oil or natural gas. During the year 1928 between 177 and 178 millions of barrels of Portland cement were produced in the United States, requiring approximately 8,000,000 tons of pulverized coal.

No particular quality of coal within practical limits has proved absolutely necessary for rotary kiln burning. Coals having a wide range of per-

centages of volatile, fixed carbon and ash can be burned for producing cement clinker. In general, fine grinding of the coal is essential. To obtain the best kiln efficiency, coal should be ground to between 75 to 85 per cent through 200 mesh sieve. High fineness reduces the percentage of ash contamination of the material. It can be safely stated that coals varying from 25 to 35 per cent volatile and not exceeding 12 per cent ash are the most desirable for burning cement clinker. Where coals of this nature are available at a reasonable price, they are the most desirable to use with the arrangement and type of burning equipment found in the modern cement plant. The fuel consumption per barrel of cement produced varies due to the sizes of kilns, difference in the process, and in the nature of raw materials used. It can be generally stated that about 100 pounds of pulverized coal are required per barrel of Portland cement clinker burned.

There are today in the United States approximately 200 pulverized fuel plants installed in connection with the iron and steel industries, serving approximately 2,500 furnaces which use approximately 3,000,000 tons of bituminous coal annually.



Typical water cooled furnace for burning powdered coal

A very great increase of interest has been shown in this fuel during the past year and all indications now point to a rapid increase in its use. In the early installations there was much guess work as to proper needs and some grief was experienced which has taken study to correct.

In the past few years it has come to be realized that there is a vast difference between the burning of pulverized coal in boiler furnaces or cement kilns and its combustion in metallurgical furnaces. Successful operation in metallurgical work requires that the material being heated or melted shall not become contaminated. This requirement, which is not present in boiler firing practice, makes it necessary to have a clean flame and much more accurate control of the fuel. To insure these it has been found necessary to pulverize the coal more uniformly fine. To prevent the packing together of the particles it has

Burner installation for vertically fired powdered fuel furnaces

been found advisable to reduce the surface moisture content. Improvement of equipment has been rapid and today pulverized coal plants are installed that are clean in operation and require a minimum of attention.

Thus, advancement on the heating side of metallurgical work has heretofore been made in the preparation of the fuel and the method of burning it, rather than in the design of the furnace. More recently the latter has been given increasing attention. Changes in roof design and combustion chamber, for example, on a continuous heating furnace from the old standard practice of necked roof have practically doubled the output in one plant. Similarly, other recent investigations have led to some rather radical changes in furnace design, and as time goes on, developments along this line will no doubt show increases in economy as great as have hitherto been effected by changes in fuel and improvements in preparation equipment.

Though less generally advertised than many other industries, the non-ferrous metal industries are today perhaps the third largest users of pulverized fuel. The total consumption of such fuel at the present time is estimated at approximately 3,000,000 tons annually.

The first pulverized coal plant to be built at a copper smelting works was at the Cananea Consolidated

Copper Company's plant, located at Cananea, Sonora, Mexico, about 1908. This plant was built to furnish pulverized coal for 500-ton reverberatory copper smelting furnaces. An installation for the International Nickel Company's smelting plant located at Sudbury, Canada, and still a third one in a southwestern smelting plant were also made about this time. Such troubles as were experienced were gradually ironed out and the art of powdered coal burning as specifically applied to smelting furnaces was gradually put on a satisfactory commercial basis.

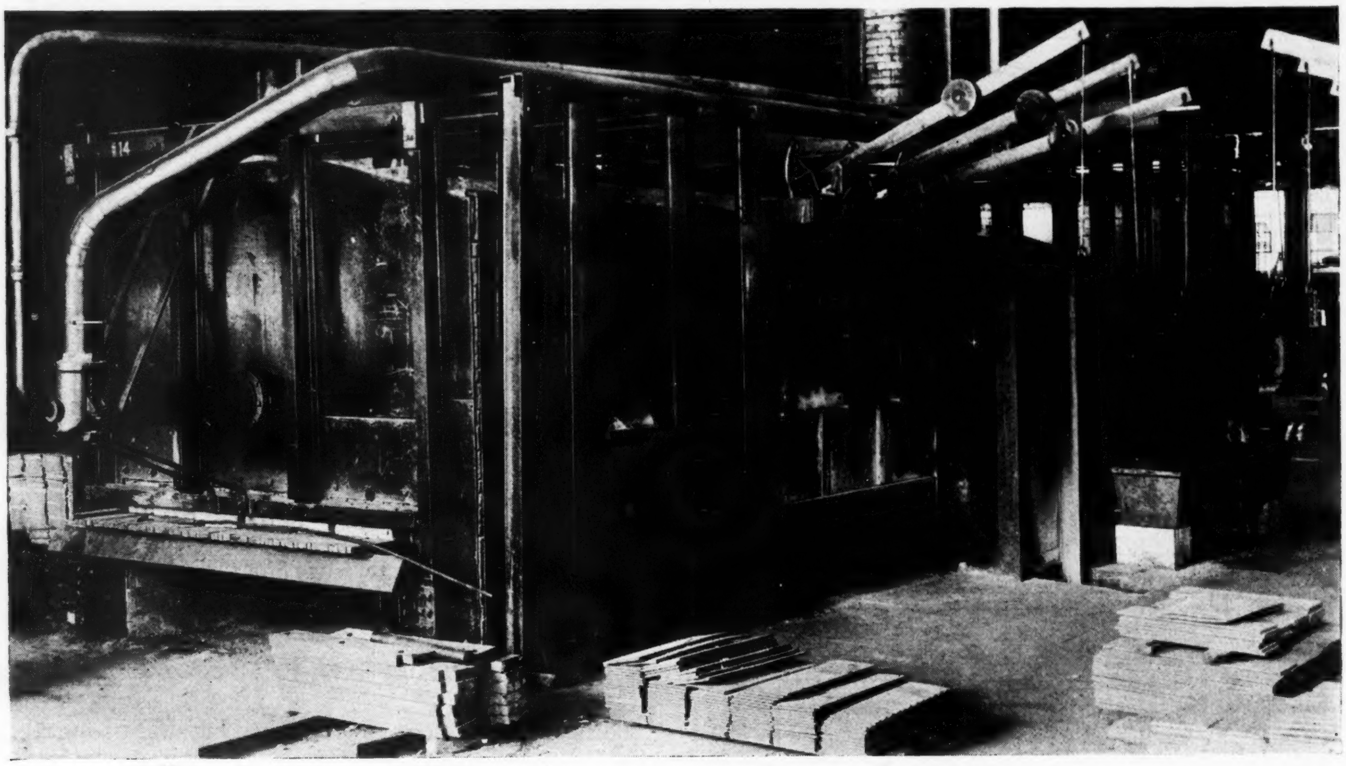
After these first three installations, the application of pulverized coal for reverberatory smelting progressed quite rapidly throughout the various copper smelting plants in the southwest and elsewhere. Results obtained were in all cases, so far as is known, entirely satisfactory. Most of the plants were originally equipped for burning oil. No instances are on record of a plant returning to oil after pulverized coal had been installed. This is in spite of the fact that these plants were equipped to burn either oil or coal. Even at times when the cost of oil, based on a B.t.u. basis, was less than coal, the plants continued to use coal as fuel. This was due mainly to the ease of control of pulverized coal and the character of the flame produced, which gave lower fuel costs per ton of charge smelted than the lower priced oil.

In every case where pulverized coal has replaced other fuels, it is highly satisfactory and considered next to gas for furnace work. In general, it may be said that pulverized fuel has proven an accepted success for the firing of copper and zinc reverberatory furnaces, copper and brass melting furnaces and ore roasting and nodulizing kilns; while, under especially skilled technical supervision, successes have also been recorded in the firing of roasting, smelting and reducing furnaces.

Powdered fuel was considered as a possible fuel for marine boilers by the United States Navy, which, shortly following the Civil War, conducted a series of tests at the Boston Navy Yard. These tests, however, did not prove an economic success. Sporadic research on this problem continued for fifty years thereafter, until shortly after the close of the World War, when the Shipping Board, in cooperation with the Bureau of Mines, again initiated a very extensive series of tests at Chester and Erie, Pa., which again proved unsuccessful from an economic standpoint.

Finally in 1925-26 the Shipping Board, in cooperation with the Navy and certain manufacturers, instituted tests which have continued until the present time, and which it is believed at last have provided a basis for successful commercial and economic development. Efficiencies of the order of 75 per cent to 80 per cent (slightly higher than those obtainable with oil) and continuous dependability, with substantially smokeless operation and capable of efficient usage with the labor usually obtainable at sea, were conclusively proven during these tests.

With the then competitive bunker prices of coal



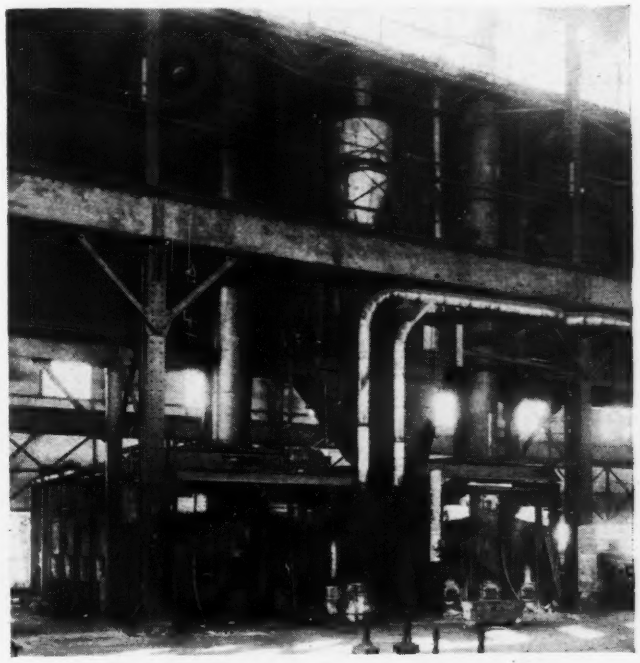
Powdered coal fired sheet and pair furnace

and oil there was a saving of nearly half the cost of liquid fuel. Unfortunately for the new development, however, flush oil production, developing almost immediately on the completion of these tests, so depressed the price of oil that progress in the practical application of the new development was delayed. In spite of this handicap, however, twelve ships to date throughout the world are either in service or under construction for powdered coal firing. As is well known, the first of these was the Shipping Board freighter S. S. Mercer, which has now completed seven successful voyages across the Atlantic, thereby writing a new page in marine engineering history. There are today in operation or under construction 11 instances of powdered coal for marine boilers. In general this method of burning fuel has proved successful and though powdered coal will perhaps never be a universal formula for all trade routes, unquestionably it will ably aid the coal industry in recovering part of the marine field now lost to oil. Also, dependent upon the particular trade route, it will unquestionably serve materially to slow up programs of marine Dieselization, or further conversions to oil firing.

Experimental work in connection with the use of bituminous and anthracite coal and lignite in pulverized form, for steam locomotive use, was actively commenced in 1913. Up until the commencement of the World War a number of railroads joined in this work and a considerable amount of success was achieved.

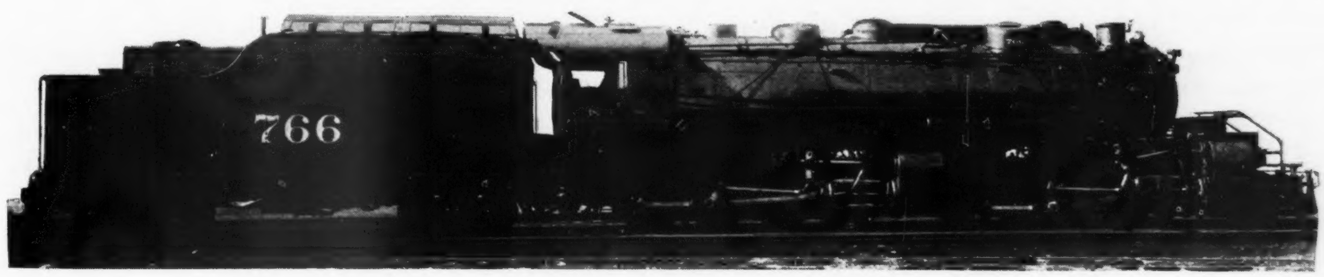
Owing to the conditions brought about by the war, this experimental work (being conducted for the purpose of developing a single equipment that would be suitable for all different kinds of anthracite and bituminous coals and lignite throughout the United States) was discontinued during the Federal control period of the railroads. Even then, however, the results obtained demonstrated the great thermal advantage in the burning of solid fuels in suspension in a manner similar to gas or oil They also brought out the advantages of a unit system for the pulverization and direct firing of the coal in the quantities as required over the central, or storage bin system, particularly for the smaller capacity boilers. They further demonstrated the greater efficiency and economy of short as compared with long-flame combustion.

In 1925 the Kansas City Southern Railroad commenced experiments with powdered coal in connection with oil burning and as a result of experimental and development work during the past three years they are now equipping a second locomotive with powdered coal. The German state railways are experimenting with the "Cassel" type of powdered coal equipment on two locomotives, while in Brazil and Japan several locomotives are in service with this type of firing.



Slab heating furnaces for blue annealed sheets, powdered coal fired

The method for firing the powdered coal, lignite or oil is practically the same so far as the firemen's operation is concerned. The use of inferior grades of coal and lignite in pulverized form also offers operating savings, and the thermal efficiency of the steam locomotive is increased as a whole. As a pulverized fuel flame possesses a narrow zone ahead of it in which the combustible gases are being heated and, as autoignition takes place well ahead of the flame, a powdered fuel-air mixture has the advantage of quick ignition, which means rapid flame propagation and less heat loss due to incomplete combustion and unconsumed fuel.



Locomotive of Kansas City Southern Railroad equipped for powdered coal firing

How to Calculate *the* Loss Due to Water Vapor in Air Used *for* Combustion *of* Fuel

By B. J. Cross

Combustion Engineering Corporation, New York

Each month one of the important calculations in steam power plant engineering will be discussed in this department. COMBUSTION readers will find here the formulas that are used, with a short explanation of their derivation and use. The full page chart, for graphic solution of the formulas discussed, will save the busy engineer many an important moment during his frequent calculations.

THE loss due to the heat required to superheat the moisture in the air used for combustion to the temperature of the stock gases is small and is usually disregarded or estimated. It should, however, always be considered in making a test by the heat balance method as by this method of determining efficiency, the maximum total loss should be determined.

The observations necessary in the determination of the loss due to water vapor in air are those of the wet and dry bulb temperatures. These temperatures may be obtained by means of a sling psychrometer or if forced draft is used, by hanging a wet and a dry bulb thermometer at the inlet of the forced draft fan. The air velocity at the wet bulb should be not less than 15 feet per second.

The wet and dry bulb temperature being known, the partial vapor pressure of the atmospheric moisture may be computed from the following equation.

$$E = E' - .000367\, P\,(t - t')\left(1 + \frac{t' - 32}{1571}\right)^*$$

E = Vapor pressure of atmospheric moisture
E' = saturation pressure at wet bulb temperature.
P = atmospheric pressure
t = dry bulb temperature
t' = wet bulb temperature

All pressures are in inches of mercury and temperature are in deg. fahr. This equation is not accurate at temperatures over 140 deg. fahr. The lb. of water vapor per cu. ft. and the "lb. per lb. dry air" corresponding to the atmospheric vapor pressure as determined may be obtained from standard steam tables.

The U. S. Weather Bureau has prepared tables by which the dew point or saturation temperature may be obtained directly from the wet and dry bulb temperature readings.** The vapor pressure of the atmospheric moisture corresponding to this saturation pressure may then be taken from the steam table.

The determination of the water vapor per lb. dry air is rather involved and requires reference to data from a number of sources.

The curves on the opposite page have been prepared by the general method given above from data obtained from Government Weather Bureau report 235, by C. F. Marvin and from Goodenough Steam Tables. The upper group of curves gives the "moisture per lb. dry air" directly from the dry bulb temperature and the wet bulb depression (dry bulb temperature minus wet bulb temperature). The lower curve gives the heat loss per lb. of water vapor for different temperature differences,—(exit gas temperature minus room air temperature). As the moisture in the air is already in vapor form it is only necessary to superheat it from room temperature to the temperature of the stack gases. The equation for this lower curve is then $h = 1 \times (T_2 - T_1) \times .47$.

The moisture per lb. dry air is first taken from the upper curve. This figure is then multiplied by the lb. dry air used per lb. fuel. The total water vapor thus obtained is multiplied by the heat per lb. of vapor as obtained from the lower curve.

Assume the following conditions,—
Dry bulb — 80 deg. fahr.
Wet bulb — 70 deg. fahr.
12 lb. air used for 1 lb. fuel.
Room temperature 80 deg.
Stock temperature 580 deg.

The heat loss would be determined as follows. From the 80 deg. dry bulb temperature on the upper curve, trace horizontally to the 10 deg. depression curve; from this intersection, trace to the bottom horizontal scale to the moisture per lb. dry air — .0137. As 12 lb. of air are used per lb. of fuel, .0132 × 12 = .1534 lb. of water vapor accompanying the 12 lb. of air.

From the lower curve, for a 500 deg. fahr. temperature difference it may be seen that 1 lb. of water vapor requires 235 B.t.u. to superheat it from 80 deg. to 580 deg. fahr. The loss per lb. of fuel is, therefore, 235 × .1584 or 37 B.t.u.

*Prof. Ferrel—Annual report Chief Signal Officer. App. 24, pp. 233-259.
**U. S. Weather Bureau Bulletin No. 235.

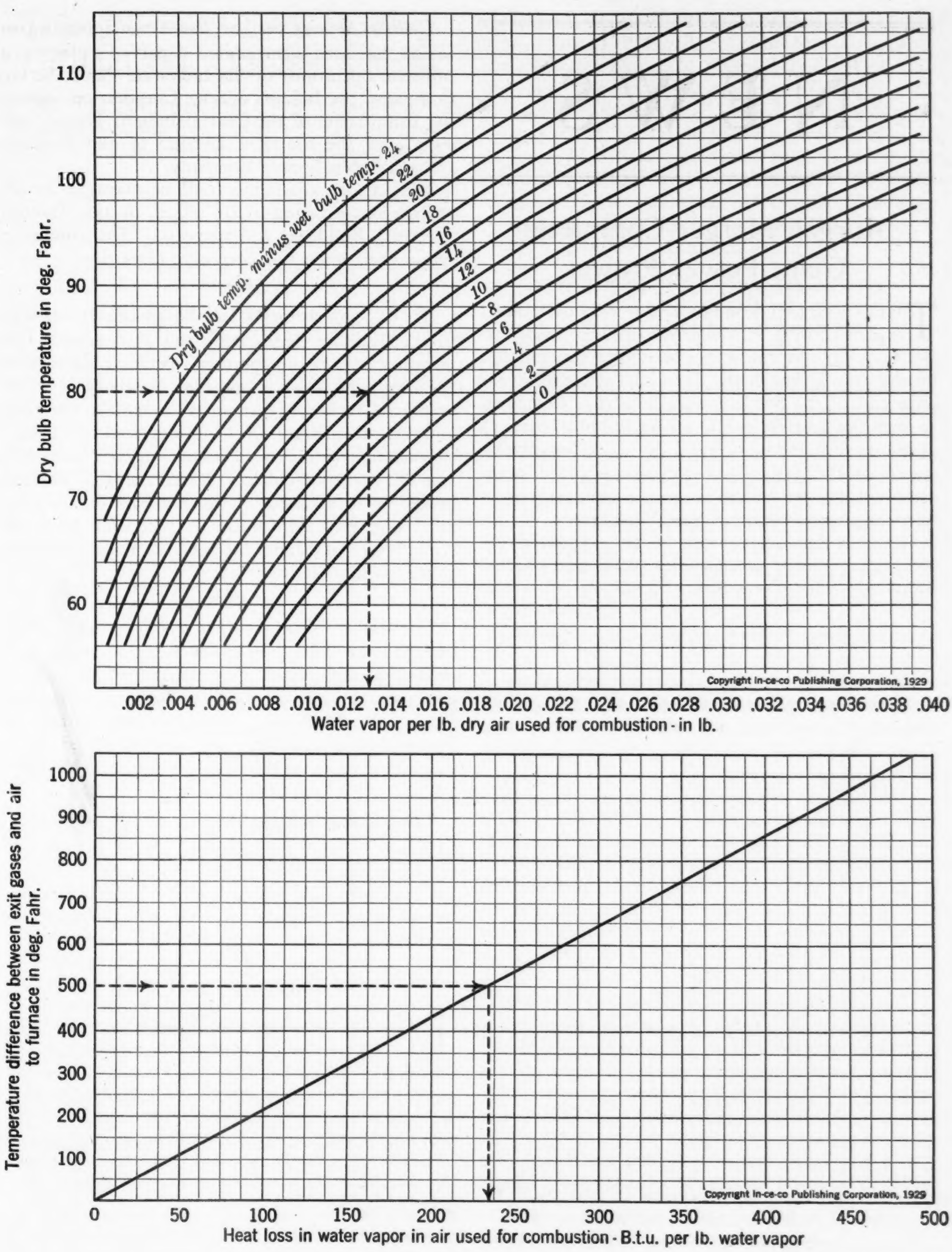


CHART FOR DETERMINING LOSS DUE TO WATER VAPOR IN AIR USED FOR COMBUSTION OF FUEL

No. 3 of a series of charts for the graphical solution of steam plant problems

· NEWS ·

Morgan Merger Completes Giant Power Project

THE Niagara Hudson Power Corporation recently organized by J. P. Morgan & Co., and associates as a $450,000,000 project, has been further augmented by the acquisition of the Frontier Corporation and securities of the St. Lawrence Securities Company, to form the greatest public utility holding company in the world. To the original 1,700,000 horsepower system another 3,400,000 horsepower is added by the combination, and control is now held of nearly every important water power in New York State.

The Frontier Corporation is an extremely important acquisition as it includes islands and riparian rights adjoining Long Sault Rapids on both sides of the St. Lawrence as well as the stock of the St. Lawrence River Power Company, Ltd., of Cornwall, Ont.

The interests controlling the merger have expressed a desire to cooperate with state and government authorities in working out the details of operation. Thomas W. Lamont of J. P. Morgan & Co., has made the following statement:

"Neither J. P. Morgan & Co., nor, so far as they know, any of the companies in which they have any interest, direct or indirect, have taken any position for or against public or private ownership of the St. Lawrence River water power or the manner of its development. In our opinion, these are matters for the determination of the Government of the United States and the government of the State of New York and by the Canadian authorities.

"In so far as we have any opinion in the matter, it is our belief that, speaking generally, these power companies are abstaining, and should continue to abstain, from intervention in the decision of this question and should loyally cooperate in the decision of the public authorities when that decision has been arrived at."

The West Virginia State Board of Education has added to the state high school curricula, an elective course in elementary coal mining, starting with the present school year. The Board recommends this course of study to the mining communities of the State and urges the local boards of education to avail themselves of this opportunity. It is believed that this is the first course in mining ever made available to high school students.

Utilities Service Inc., an Insull managing organization, has been incorporated as part of a plan to coordinate operations of the Interstate Public Service Company, the Indiana Service Corporation, operating subsidiaries of the Central Indiana Power Company, and the southern division of the Northern Indiana Public Service Company.

The various companies will be managed by the central organization with offices in the Traction Terminal Building, Indianapolis. The companies retain their respective corporate identities.

W. G. Jens, formerly Pittsburgh branch manager of the Byllesby Engineering and Management Corporation, has been appointed operating manager of the Duquesne Light Company, Pittsburgh, to succeed Edward W. Judy, recently elected vice-president and general manager. A. G. Butler, formerly general superintendent of construction for the Louisville Gas and Electric Company, Louisville, Ky., has been promoted to manager of the Byllesby organization at Pittsburgh. Mr. Butler is succeeded by G. R. Armstrong, assistant superintendent of construction at Louisville since 1922.

The Bailey Meter Company of Cleveland, Ohio, manufacturers of power plant metering and control equipment announces the transfer of its Boston Office to 523 Public Service Building, 89 Broad Street. P. T. Reuter, who has represented the Bailey Meter Company in New England for a number of years, will continue as Branch Manager.

The Dunbar Engineering Company, New York City, representing the Edward Valve & Manufacturing Company of East Chicago, Indiana, announces the removal of its offices from 50 Church Street to the Chanin Building, 122 East 42nd. Street, New York City.

Bituminous Coal

THE total production of Bituminous coal during the week ended September 7th, according to the Bureau of Mines, was estimated at 9,408,000 net tons, as against 10,689,000 tons in the preceding week, a decrease of 12 per cent. The daily average production for the week ended September 7th was 1,775,000 tons as compared with 1,782,000 tons for the previous week and 1,655,000 tons for the corresponding week in 1928.

The total production of bituminous coal during the present calendar year to September 7th, amounted to 347,137,000 net tons. Figures for corresponding periods in other recent years are given below:

Net Tons	Net Tons
1928—319,900,000	1926—365,369,000
1927—359,574,000	1925—330,659,000

Third National Fuels Meeting Philadelphia, October 7 to 10

THE Third National Fuels Meeting will be held in Philadelphia, Pa., October 7 to 10, 1929, with meeting headquarters in the Bellevue-Stratford Hotel.

A comprehensive program of papers has been arranged covering a wide range of subjects related to fuel utilization, including the following:

The reclamation of anthracite culm, burning refuse fuels, low temperature carbonization of coal, the atomic basis of combustion theory, economics of gas, coal and oil fuels, economics of oil production, heat value of fuel, coal pre-treatment, slag accumulations on boiler tubes, air needed for combustion of different fuels, design of furnace for tunnel kilns, development of refractories, producer gas in brick kilns, fuel burning in ceramic and lime industries, application of fuels in the cement industry, burning pulverized anthracite, recent developments in stoker design, burning coarse coal in suspension, proper methods of sampling pulverized fuel, low-temperature coke for marine service, pulverized fuels in marine practice, methods of recording smoke, the effect of pulverized fuel ash on the penetration of ultra-violet rays.

Smoke abatement will receive particular attention at this meeting. At least one full day will be devoted to papers and discussions on this subject.

The World Power Conference, second meeting will be held in Berlin from June 16 to June 25, 1930. Berlin was selected by unanimous resolution of the 47 member nations of the conference. O. C. Merrill, Washington, D. C., is chairman of the American Committee of the World Power Conference.

The Eighth National Exposition of Power and Mechanical Engineering will be held at Grand Central Palace, New York City, opening December 2 and continuing throughout the week. In 1922 the attendence at the show was only 47,589. Last year the attendance increased to 123,000 and the number of exhibitors was 542 in 1928 as compared to 105 the first year of the exposition.

Coincident with the National Power Show, the American Society of Mechanical Engineers will hold its annual meeting in New York City.

The advisory committee of the National Power Show is made up of the following engineers: I. E. Moultrop, chairman, Edison Electric Illuminating Co., Boston; Homer Addams, past president, A. S. H. &. V. E.; A. Black, chairman, professional divisions, A. S. M. E.; N. A. Carle, general manager, Pacific Electric & Manufacturing Co.; Fred Felderman, past national president, N. A. P. E.; F. M. Gibson, chairman, power division, A. S. M. E.; C. F. Hirschfeld, chief of research department, Detroit Edison Co.; O. P. Hood, chief mechanical engineer, United States Bureau of Mines; John H. Lawrence, president, Thomas E. Murray, Inc.; Thornton Lewis, president, A. S. H. & V. E.; Fred R. Low, past president, A. S. M. E.; David Moffatt Myers, consulting engineer; M. S. Sloan, president, N. E. L. A.; Arthur J. Wood, president, A. S. R. E. Fred W. Payne and Charles F. Roth, with offices in Grand Central Palace, New York, will manage the National Power Show.

Anthracite Equipment Corporation Organized

THE Anthracite Equipment Corporation has been organized with the election of the following board of directors: Eliot Farley, president D. L. & W. Coal Company; A. J. Maloney, president Philadelphia & Reading Coal & Iron Company; Daniel T. Pierce, vice-chairman Anthracite Operators Conference; Thomas Dickson of Dickson & Eddy, and C. A. Connell, acting manager, Anthracite Coal Service. Daniel T. Pierce was elected president and A. S. Moody, secretary and general manager. The offices of the new organization will be at 120 Broadway, New York.

The corporation will finance and promote the sale of improved heating and heat control devices which have been tested and approved by the research laboratory of the Anthracite Operators Conference.

The Graver Corporation, East Chicago, Indiana, manufacturers of water treating apparatus, announces the appointment of William E. Dunbar as southeastern sales engineer, with offices at Florida Theatre Building, Jacksonville, Fla. His territory will include the states of Florida, Georgia and Alabama.

The Link Belt Company, Chicago, Ill., announces that E. J. Burnell formerly district manager of the Pittsburgh office has been appointed sales manager of the Western division. Nels Davis of the Chicago engineering sales organization will succeed Mr. Burnell as Manager of the Pittsburgh district.

James T. Hutchings Dies

JAMES T. HUTCHINGS, vice-president in charge of engineering development, United Gas Improvement Co., died suddenly of heart disease on Saturday, August 17, at Ocean City, N. J. He was 60 years of age.

Mr. Hutchings entered the employ of the U. G. I. Co., in 1920 as assistant general manager. The following year he became general manager and two years later was elected vice-president in charge of operations. In 1927 he became vice-president in charge of engineering development.

NEW CATALOGS AND BULLETINS

Any of the following literature will be sent to you upon request. Address your request direct to the manufacturer and mention COMBUSTION Magazine

Automatic Control

A new catalog, No. 181, describes the features of Bailey Control such as, automatic adjustment of fuel and air; the maintenance of any desired excess air at any rating; and a master pressure contactor which anticipates changes in steam pressure and sends out impulses to provide for the new conditions before they actually appear. It also explains how flexibility in both operation and application is secured through the use of selective drum switches, intermittent drive units, high speed reset clutches, and other mechanisms which make possible the safe automatic operation of dampers and fan motors in the proper sequence. 44 pages, 8½ x 11—Bailey Meter Company, Cleveland, Ohio.

Boilers

C-E Box Header Boilers of both the Heine and Walsh & Weidner types are now built with a single header seam and a single row of rivets. The resulting construction is stronger and provides a much higher factor of safety than the ordinary box header design. The advantages of this improved construction are outlined in a new folder. 4 pages, 8½ x 11—Combustion Engineering Corporation, 200 Madison Avenue, New York.

Boiler Baffles

The Turner Baffle and the Beco Baffle are illustrated and described in two bulletins "Which do you Prefer" and "A Baffle Wall that is a Real Baffle Wall." The methods of construction are shown and numerous illustrations show baffle designs adapted to various types of water tube boilers. 4 pages each, 8½ x 11—Boiler Engineering Company, 931 Federal Trust Building, Newark, N. J.

Boiler Feed Water

"Reducing Fuel and Boiler Plant Operating Costs" is the title of a new booklet by B. H. Miller, which discusses boiler feed water and suggests ways of correcting faulty conditions. The Permutit Zeolite Softener is featured, however other methods of water treating are described including combinations of Zeolite and other processes. 16 pages and cover, 8½ x 11—The Permutit Company, 440 Fourth Avenue, New York.

Cast Iron Storage Tanks

Hahn Sectional Cast Iron Storage Tanks of the bottom discharge type are illustrated and described in new bulletin No. 12. The tanks are built up of non-machined cast iron sections and are recommended for the storing of corrosive and abrasive materials such as, ashes, coal, coke, sand and gravel. 6 pages, 8½ x 11—Hahn Engineering Company, Division of Lancaster Iron Works, Lancaster, Pa.

Combustion Control

The Lee Precision Control of Furnace Draft is illustrated and described in an attractive new catalog. The requirements of furnace control are outlined and numerous colored charts illustrate the furnace conditions incident to correct and incorrect draft regulations. 16 pages and cover, 8½ x 11—Gillette-Vibber Company, New London, Conn.

Conveying Equipment

The new Rex catalog No. 330 and Engineering Data Book is devoted to power transmission, mechanical conveyors and water screens. The catalog is very complete and contains much valuable engineering information on these subjects. The mechanical handling problems of numerous representative industries are covered in detail. 800 pages—Chain Belt Company, Milwaukee, Wis.

Feed Water Regulators

"Modern Feed Water Regulation" is a new catalog describing the Copes system of boiler feed control. In addition to the standard Copes regulator, a new design known as the "Type R" is presented for use with steam pressures of 300 pounds and above. Numerous illustrations show the details of design and application arrangement of the Copes Regulator and the Copes line of Pressure Regulators and Valves. 16 pages, 8½ x 11—Northern Equipment Company, Erie, Pa.

Feed Water Treatment

There are two general types of boiler feed water treatment, chemical and colloidal. The Filtrator method, which employs the colloidal principle, is fully described in a new booklet, "Reducing the Cost of Boiler Operation with Filtrators." A flax seed emulsion which is introduced into the boiler feed water, acts as a colloid and forms a film on the particles of solid matter which are suspended in the water, thus preventing them from adhering to each other or to the boiler surfaces. These solids gradually settle in the boiler at points of low circulation and are ejected in the regular blow down. 20 pages, 8½ x 11—Filtrators Company, 96 Liberty St., New York.

Hammer Welded Boiler Drums

Kellogg Forge and Hammer Welded Boiler Drums and Pressure Vessels are described in two recent publications—an illustrated folder and a reprint of a technical paper, "The Effect of Cold Working on Boiler Drums." Microphotographs of metal sections are reproduced to show the effects of hot and cold processes on the metal structure. 4 pages and 8 pages respectively, 8½ x 11—M. W. Kellogg Company, 225 Broadway, New York.

Power Plant Appliances

A new condensed catalog presents the Huyette line of Steam Plant equipment and instruments. A wide variety of appliances is shown including, Water Gages, Water Columns, Soot Blowers, Tube Cleaners, Draft Gages, CO2 Instruments, Flow Meters and Boiler Control apparatus. 24 pages and cover, 8½ x 11—The Paul B. Huyette Co., Inc., 5 South 18th St., Philadelphia, Pa.

Pulverizing Mills

Raymond equipment for drying, pulverizing and transporting various materials is covered by a new folder. A wide range of equipment is presented including, Roller Type Mills, Impact Type Mills and Super-Mills. 4 pages, 8½ x 11—The Raymond Brothers Impact Pulverizer Company, 1311 North Branch St., Chicago, Ill.

Smoke Abatement

Bulletin No. 103 describes the Drake Improved Combustion System with particular reference to Smoke Abatement. The theoretical requirements of complete combustion are briefly outlined and compared with the Drake principle of "Turbulence without Excess Air" to show the correctness of the Drake System. 4 pages, 8½ x 11—Drake Non-Clinkering Furnace Block Company, 5 Beekman St., New York.

Soot Blowers

Bayer Steam Soot-Blowers are described in detail in an attractive three color booklet. The features of design of various types of Bayer Blowers are illustrated and 16 sketches are included to show application arrangements and proper location of blowing elements for different types of boilers. 24 pages and cover, 8½ x 11—The Bayer Company, St. Louis, Mo.

Steam Piping Bends

Pittsburgh Creased Piping Bends are presented in a new folder and the following advantages are outlined as compared with the old type of plain expansion pipe bend—greater elasticity (a ratio of approximately 5 to 1 for bends of the same size); uniform wall thickness maintained throughout; less surface area and lower heat loss; lower pressure drop; less space required. 6 pages, 8½ x 11—Pittsburgh Piping & Equipment Company, 43rd St. and A.V.R.R., Pittsburgh, Pa.

Stokers

The C-E Multiple Retort Underfeed Stoker (Super-Station Type) is illustrated and described in a new catalog MR 2. The principles of underfeed firing are set forth and the operation of the multiple retort stoker is described in detail. The catalog is profusely illustrated to show the features of construction and setting drawings are reproduced to show the application of the stoker to various types of boilers. 48 pages and cover, 8½ x 11—Combustion Engineering Corporation, 200 Madison Avenue, New York.

Vacuum Cleaners

Sturtevant Vacuum Cleaners (Stationary Type) are presented in a new catalog No. 368. In the stationary type of cleaner, the motor, vacuum producer and dirt separator may be located in the basement or other out of the way place. In power houses and coal preparation plants, the complete unit may be located over the coal bunkers or storage bins. Piping is run to all parts of the building with connections for cleaning hose conveniently located. 8 pages, 8½ x 11—B. F. Sturtevant Company, Hyde Park, Boston, Mass.

Vibrating Screens

Tyler Hum-mer Electric Vibrating Screens are presented in a new catalog No. 54. A wide variety of materials are covered and dimension drawings are included for the full range of screens manufactured. The vibrating screen principle is compared with other methods of screening and numerous illustrations show the application of Hum-mer Screens. 96 pages and cover, 8½ x 11—The W. S. Tyler Company, Cleveland, Ohio.

REVIEW OF NEW TECHNICAL BOOKS

Any of the books reviewed on this page may be secured through In-Ce-Co Publishing Corporation, 200 Madison Avenue, New York

Exhaust Steam Engineering

By Charles S. Darling

THIS book is written with the purpose of explaining how economies may be effected by other uses of steam than merely to produce power. Its thorough treatment of the entire subject of steam usage makes it desirable as both a handbook and a reference book for consulting engineers and others interested in the design of complete modern industrial steam plants.

There are several chapters which discuss that part of thermodynamics ordinarily required for the handling of practical plant design. The discussion is not only concise and clear, but is copiously illustrated with specific examples and easily understood charts and diagrams, which have evidently been drawn expressly to complement the text.

Following this theoretical matter are many chapters dealing with the various classes of equipment available for furnishing and using exhaust steam. Back-pressure engines and turbines are treated both as pieces of mechanical equipment and as vehicles for the translation of the theoretical into practical economies.

Accumulators constitute, of course, an important section of the subject matter. Not only are the leading types illustrated, and their hook-ups shown in a number of diagrams, but the calculations for their proportioning and for fitting them into a plant steam system are also thoroughly covered. Control systems for accumulators are discussed in a separate chapter.

Pipe lines in plant and steam distribution systems for municipal heating, receive special treatment in three chapters.

The chapter on "Capital Expenditure and Fixed Charges in Industrial Plants," contains a wealth of useful data. In addition, methods for handling the financial problem are discussed. Examples are cited from plants throughout the world.

The 431 pages of this book are exceptionally rich with material of practical value. Every illustration, table or curve is precisely suited to the context. Explanations of engineering or scientific principles are brief and clear and very many practical calculations of concrete examples are used to drive home the thoughts. It is this method of treatment that makes the book of special value as a handbook for the solution of steam plant problems. In his preface, the author states that he has written from the viewpoint of the user and consulting engineer. He further points out that the subject matter may be useful in the renovation of old plants, as well as in the design of new ones.

The chapters average only about 20 pages each, which makes for easy reading. They also form an automatic index of the subject matter that will be sufficient for most purposes. In addition, however, there is the customary index at the back of the book for locating specific references.

The book is bound in cloth in the handy 5¾ x 8¾ size and is priced at $7.50.

Power Resources of the World

Potential and Developed

This book is an important compilation of the combined data from some 47 countries of the world. The 1929 edition is in cloth covers, in 6 x 10 size and comprises 170 pages. Copies may be obtained in the United States, at $4.25 each, all charges prepaid, by addressing American Committee, World Power Conference, Washington, D. C.

THE statistical data gathered for this volume have required an immense amount of labor, which could be expended only by an organization having the resources of the World Power Conference. Differences in standards, and in methods of keeping records, in the various countries, were a gigantic handicap to this compilation; but these have been already overcome to a great extent, and the way is paved for even more accurate listing and comparison of these World Resources in the future.

Distinction is carefully made between the resources of coal, oil and gas, and of water power, on the one hand, and resources of vegetable origin on the other hand.

At a time when great industrial countries, in the possession of vast financial reserves, are still in ignorance of how best to use those reserves and ensure a continuous demand for their products, a survey of the power resources and power production of the world is a matter of urgent importance.

It is pointed out that the exchange of information, while it renders international relations much more cordial and brings the main industrial countries into closer union, must also be of benefit to every country engaged in the work of contributing to this fund of world knowledge of Power Resources.

• NEW EQUIPMENT •

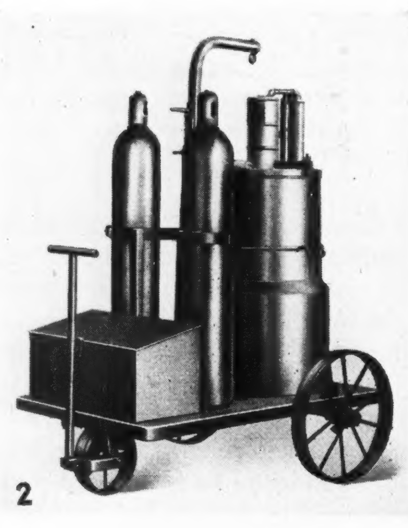
Two New Trucks for Carbic Generators

THE Oxweld Acetylene Company, 30 E. 42nd Street, New York City, has recently introduced two new types of trucks to accommodate Type CLP-3 and Type CLP-2 Carbic low-pressure acetylene generators, respectively.

There have been numerous requests for a truck suitable for the CLP-3 Carbic Generator, and introduction of the larger model also fills a very definite need in the welding and cutting field.

The truck designed to carry a CLP-3 Carbic Generator also carries two cylinders of oxygen. It is sturdily constructed throughout and oxy-acetylene welded. Two large wheels carry the back part of the truck; a third wheel, in the front, is of the castor type and allows the truck to be turned in a radius about equal to its own length. The generator is secured to the steel deck of the truck by means of angle iron braces and two long bolts which are inserted in the handles of the generator and tightened by means of turnbuckles.

The truck is provided with a steel tool box with loop fastenings. This box can be



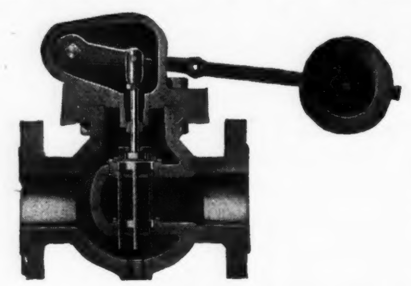
2

used for wrenches, small tools, or for a welding or cutting outfit. The oxygen cylinders are chained to a steel rack which is fastened to the deck of the truck beside the generator. A sturdy crane is provided to be used in charging and emptying the generator. With this crane it is an easy matter to lift the gas-bell out of the generator. The water and residue can then be drained off through the outlet at the bottom. The crane jib is made in three sections which can be telescoped when not in use to decrease the height.

The smaller truck will accommodate one cylinder of oxygen in addition to the Type CLP-2 Carbic Generator. It is designed for extreme portability and can be wheeled anywhere with ease. There are two 24-in. steel wheels and one 5-in. castor wheel operating on a roller bearing. All wheels are provided with grease cups for lubrication.

A Balanced Control Valve with Rotating Stem

A NEW Copes Control Valve has been brought out by the Northern Equipment Company, Erie, Pa. This valve, instead of having the usual style of sliding valve stem, is operated by a rotating shaft which reduces the friction of the valve stem in the stuffing box to a minimum. While the valve itself

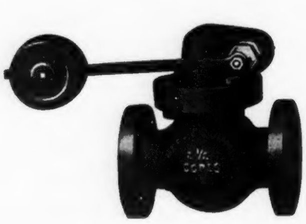


has a lift of approximately one inch, the actual rotating movement of the shaft is only 3/16 of an inch at its periphery for full valve travel.

The actual friction of the rotating stem is of the order of 9 ounces instead of being of the order of 16 pounds as would be the case with an ordinary sliding spindle.

The valve is particularly useful for conditions requiring very sensitive control and in other similar conditions where the actuating force is very slight. The inside diameters of both valve seats are exactly equal thus constituting a truly balanced valve. The size and shape of valve ports are made in designs to suit each service condition. The rotating stem with its extremely low friction is especially dependable and accurate in response to the most sensitive flow controls where the actuating force is slight.

This Copes type BI valve is ideal for controlling make-up water and water levels for feed water heaters, open tanks, evaporators, heating system return tanks, sump pumps, and for the control of reducing valves. It is also suitable for controlling and regulating the steam supply to stoker drive and to fan engines, and it can be adapted for manual control of flow and for high pressure service. The valve is supplied in all sizes with ports having flow areas exactly suited to operating conditions. Accurate data are available which show the exact amount of water that can be passed through this valve at any pressure drop.



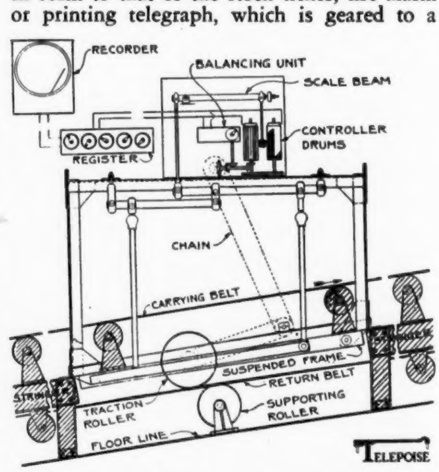
The high lift of the valve together with special narrow width valve ports gives an ideal control of flow with an almost complete elimination of wire drawing. The wide range of flow area is made possible by the means of the different ports which can be furnished exactly to suit the necessities of each application.

A New Automatic Scale for Continuously Weighing Material in Transit on Conveyors

JOHN CHATILLON & SONS, 89 Cliff Street, New York, have developed a new automatic scale known as the "Telepoise." The machine consists of a steel frame work the lower part of which, as shown in the drawing, is a suspended type of scale. Two carrying idlers of the belt are mounted on the floating platform over which the belt travels with the load.

The weighing mechanism consists of a scale beam balanced by means of calibrated springs. Beneath the end of the beam is the integrating mechanism which consists of two drums which are caused to revolve toward each other at a speed proportional to that of the belt, by means of the traction roller and transmission as shown.

The left hand drum surface is milled into a succession of cams. The right hand drum has a smooth surface one half of which is metallic and one half non-conductive. The dividing line between the metallic and non-conductive surfaces is part of a helix so that the surfaces are like two equal right angle triangles wrapped around a cylinder, fitting together along the hypotenuse. As the drums revolve, a contactor suspended from the end of the weigh beam and moves in unison with it, is vibrated rapidly against the surface of the drum on the right by the cams on the surface of the left drum and if brought in contact with the metallic surface of the right drum, opens and closes an electric circuit; the impulses occasioned thereby, through the brushes at the top of the drums and wiring, operates an electro-mechanical device, similar in form to that of the stock ticker, fire alarm or printing telegraph, which is geared to a



continuous register at a ratio to convert the impulses into pounds, tons, barrels, etc., as desired.

A twenty-four hour chart recorder is operated by suitable wiring from register. The register and recorder may be installed at any distance from the machine or from each other.

An ingenious load indicating device is included, which by means of a projector of the magic lantern type projects an intense spot of light with a black line in its center onto a ground glass scale divided into one hundred parts, at no load, the black line rests at zero, at full load, 100.

To balance the machine a lever is used to transfer a small weight to the weigh beam and automatically cut out the load register; the controller is simultaneously connected electrically to the balancing unit, which is so arranged that it will indicate immediately whether or not the machine is in balance, and if not, what adjustment to make.

P A T E N T S

Recently granted, and of Interest to our Readers.

Printed copies of Patents are furnished by the Patent Office at 10 cents each. Address the Commissioner of Patents, Washington, D. C.

UNITED STATES PATENTS

Issued August 13, 1929

1,724,072. Pulverizing Apparatus. Fred H. Daniels, Worcester, Mass., assignor to Riley Stoker Corporation, Worcester, Mass. Filed Aug. 21, 1926.

1,724,098. Furnace - Roof Construction. John Douglas MacKenzie and Richard W. Senger, Garfield, Utah, assignors to American Smelting and Refining Company, New York, N. Y. Filed April 2, 1927.

1,724,309. Distributing Device. Thomas F. Pigott, Brooklyn, N. Y., assignor to Riley Stoker Corporation, Worcester, Mass. Filed May 17, 1928.

1,724,318. Attrition Mill. August Schuchardt, Winona, Minn. Filed June 18, 1928.

1,724,351. Heat Exchanger. Herbert Henderson and John G. Glasgow, Port Arthur, Texas, assignors to Gulf Refining Company, Pittsburgh, Pa. Filed Sept. 4, 1926.

1,724,352. Furnace for the Destruction of Garbage. Carl Christian Ilving, Copenhagen, Denmark. Filed Aug. 15, 1928; and in Denmark Aug. 20, 1927.

1,724,462. Sectional Furnace. James Doherty, Chicago, Ill.; Ella Maud Doherty and James Russell Doherty, Executors of said James Doherty, deceased. Filed March 21, 1923.

1,724,505. Boiler or Heater. Thomas E. Murray, Brooklyn, and John H. Lawrence, New York, N. Y.; said Lawrence assignor of his entire right to said Murray. Filed March 19, 1924.

1,724,560. Generation of Steam. Virginius Z. Carachristi, Bronxville, N. Y. Filed Feb. 25, 1926.

1,724,593. Stoker Conveyer. Andrew M. Hunt, New York, N. Y., assignor to Standard Stoker Company, Incorporated, a Corporation of Delaware. Filed Jan. 27, 1925.

1,724,711. Stoker - Driving Mechanism. Frederick William Hollick, Gourock, Scotland, assignor to The Babcock & Wilcox Company, Bayonne, N. J., a Corporation of New Jersey. Filed Feb. 27, 1924; and in Great Britain, Mar. 7, 1923.

1,724,876. Unit Pulverizer. Austin A. Holbeck, Cleveland, Ohio. Filed Sept. 22, 1927.

Issued August 20, 1929

1,724,895. Single-Zone Pulverizing Apparatus. David K. Beach, Worcester, Mass., assignor to Riley Stoker Corporation, Worcester, Mass. Filed May 5, 1926.

1,724,996. Boiler-Control System. Warren Doble, San Francisco, Calif., assignor to Doble Laboratories, San Francisco, Calif. Original application filed Dec. 13, 1919. Divided and this application filed Nov. 20, 1923.

1,725,029. Combustion Device. George Van Daam, Paterson, N. J. Filed Nov. 18, 1927.

1,725,135. Adjustable Cage for Crushers. William P. Gruendler, University City, Mo. Filed July 16, 1928.

1,725,198. Fuel and Process of Making the Same. Lester Kirschbraun, Chicago, Ill. Filed March 14, 1921. Renewed March 17, 1926

1,725,202. Electrical Controller for Conveying Systems. Ralph G. Lockett, Milwaukee, Wis., assignor, by mesne assignments, to Cutler-Hammer, Inc., a Corporation of Delaware. Filed Feb. 23, 1926.

1,725,226. Dual-Feeding Apparatus. Irving A. Taylor, Worcester, Mass., assignor to Riley Stoker Corporation, Worcester, Mass. Filed Nov. 10, 1926.

1,725,283. Feeder for Crushers, Pulverizers, and Belt Conveyors. Paul S. Knittel, Jersey City, N. J. Filed May 18, 1927.

1,725,399. Apparatus for Superheating Steam. Walter Douglas La Mont, Larchmont, N. Y., and Alfred F. Ernst, Passaic, N. J., assignors to La Mont Corporation, New York, N. Y. Filed July 7, 1927.

1,725,408. Vapor or Steam Generator. Charles R. Moore, Elmira, N. Y. Filed Feb. 28, 1928.

1,725,463. Water-Tube Boiler. Claude B. Lindstrom, Coscob, Conn. Filed Nov. 11, 1924.

1,725,485. Superheater Unit. Frank W. Shupert, Sanford, Fla. Filed April 18, 1927.

1,725,549. Heat - Transfer Apparatus. Frank J. Swenson, Brooklyn, N. Y., assignor to Foster Wheeler Corporation, New York, N. Y. Filed Mar. 10, 1926.

Issued August 27, 1929

17,416. Stoker Construction. Otto Aram, Allentown, Pa., assignor to Westinghouse Electric and Manufacturing Company. Filed July 10, 1929.

1,725,798. Steam Boiler. Herman C. Heaton, Chicago, Ill., assignor to The Babcock & Wilcox Company, Bayonne, N. J. Filed July 10, 1924.

1,725,828. Boiler. Joseph Rathgeb, Jr., New York, N. Y. Filed Sept. 28, 1925.

1,725,906. Heat-Transfer Means. Frazer W. Gay, Newark, N. J. Filed July 5, 1927.

1,725,920. Series Boiler and Method of Operating the Same. David S. Jacobus, Jersey City, N. J., assignor to The Babcock & Wilcox Company, Bayonne, N. J. Original application filed April 16, 1918. Divided and this application filed June 11, 1920.

1,725,921. Series Boiler and Method of Operating the Same. David S. Jacobus, Jersey City, N. J., assignor to The Babcock & Wilcox Company, Bayonne, N. J. Original application filed April 16, 1918. Divided and this application filed June 19, 1920, Renewed Feb. 11, 1926.

1,725,974. Fire and Heat Deflector and Heat Retainer. Paul P. Brautigam, Chicago, Ill. Filed December 16, 1926.

1,726,020. Water - Heating Apparatus. David F. Garvey, Chicago, Ill. Filed May 23, 1928.

1,726,050. Furnace. George Palmer Ward, Habana, Cuba, assignor, by mesne assignments, to Fuller Lehigh Company. Filed November 28, 1923.

1,726,058. Coal - Distillation Apparatus. William Moncrieff Carr, Woodcourt, Brooklands, and Thomas James Ashley, deceased, Broadstairs, England, by Alice Elizabeth Ashley, Executrix, Broadstairs, England. Filed February 25, 1926, and in Great Britain March 3, 1925.

1,726,092. Washing Hot Gas Valves. Louis Wilputte, New Rochelle, N. Y., assignor, my mesne assignments, to Wilputte Coke Oven Corporation, New York, N. Y. Filed March 25, 1922.

1,726,112. Water-Tube Boiler. Henry John Sutherland MacKay, Ryde, England, assignor to The Babcock & Wilcox Company, Bayonne, N. J. Filed July 3, 1919, and in Great Britain July 31, 1918.

1,726,234. Water-Tube Boiler. George J. Mog, Cleveland, Ohio. Filed March 26, 1924.

1,726,235. Radiator. Thomas E. Murray, Brooklyn, N. Y. Original application filed April 26, 1924. Divided and this application filed July 21, 1928.

Issued September 3, 1929

1,726,529. Boiler-Feed-Water Regulator. Bernt Garllus, Detroit, Mich., assignor to Alexander J. McDonough, Detroit, Mich. Filed Aug. 18, 1927.

1,726,552. Steam Injector. Louis Friedmann, Vienna, Austria. Filed Dec. 5, 1924.

1,726,561. Power Plant. Francis Hodgkinson and Robert C. Allen, Swarthmore, Pa., assignors to Westinghouse Electric & Manufacturing Company. Filed Nov. 11, 1924.

1,726,617. Condenser Having Increased Pitch of Flow. Norman H. Gay, Los Angeles, Calif. Filed Nov. 7, 1928.

1,726,640. Oil Burner. John Benniger, Philadelphia, Pa. Filed June 7, 1927.

1,726,721. Regulation. Tage Schullström. New York, N. Y. Filed Apr. 24, 1926.

1,726,726. Regulation. Fritz Wettstein, Summit, N. J., and Tage Schullström, New York, N. Y., assignors to Ruths Accumulator Company, Inc., New York, N. Y. Filed April 17, 1926.

1,726,730. Steam-Power Plant. Matts Bäckström and Carl Föhl, Stockholm, Sweden, assignors to Ruths Accumulator Aktiebolag, Stockholm, Sweden. Filed Nov. 7, 1927.

1,726,870. Method and Apparatus for Burning Fuels. Walter E. Trent, New York, N. Y., assignor to Trent Process Corporation, New York, N. Y. Filed April 23, 1926.

1,726,943. Heat Exchanger. Hugo Bergquist, Swissvale, and Paul T. Keebler, Jeannette, Pa., assignors to Elliott Company, Pittsburgh, Pa. Filed Feb. 16, 1928.

1,726,975. Variable-Speed Compensating Device for Fluid Meters. Carlos J. Bassler, Portland, Oregon, assignor to American Liquid Meter Company, Portland, Oregon. Filed September 6, 1921.

1,726,995. Heat - Exchange Apparatus. Everett Norman Sieder, Elizabeth, New Jersey, assignor to Foster Wheeler Corporation, New York, N. Y. Filed October 26, 1928.

1,727,097. Bar-Heating Furnace. Frank W. Brooke, Pittsburgh, Pa. Filed April 14, 1926.

1,727,177. Superheater Boiler. John Prentice, Bayonne, N. J., assignor to The Babcock & Wilcox Company, Bayonne, N. J. Filed Nov. 24, 1925.

BRITISH PATENTS

Accepted June 13, 1929

287,556. Walls, Furnaces and Installations Formed of Refractory Materials Resistant to Destructive Effects and Method and Means for their Production. Laboratoire De Perfectionnements Thermiques, 12, Rue Detot, Paris, France. Assignees of Pierre Eugene Joseph Jerome Couturaud, of 22, Rue de Tocqueville, Paris, France.

Accepted June 14, 1929

313,976. Improved Boiler Feed Water Control Means. Alexander Bannatyne Stewart Laidlaw, of Simon Square Works, Edinburgh.

Accepted June 19, 1929

314,104. Improvements in or relating to Underfeed Mechanical Stokers. Alfred Augustus Thornton, of 8, Quality Court, Chancery Lane, London, W. C. 2.

Accepted June 21, 1929

313,998. Improvements in or relating to Heat-transferring Devices, such as Air Preheaters. William Albert White, of White Engineering Works, Prince Consort Road, Hebburn-on-Tyne, County of Durham.

Accepted June 24, 1929

314,111. Improvements in Clinker Dams, Dumping Bars and the like for Furnaces. Edward James Vincent Howard Davies, of 8, Private Road, Enfield, Middlesex.

Accepted June 27, 1929

314,186. Improvements in and relating to Draught Regulators for Furnace Installations. Gustav Korngiebel, of Lessingstrasse, 8 Kassel, Germany.

296,723. Crushing, Grinding or Milling Apparatus. Rene Emile Trottier, of 84, rue de la Republique, Puteaux, (Seine), France.

314,231. Improvements in Vertical Retorts for the Carbonization of Coal and like Materials. Ernest West, and West's Gas Improvement Company Limited, both of Albion Ironworks, Miles Platting, Manchester.

314,236. Improvements in Furnace Grates. Alfred William Bennis, of Little Hulton, Bolton, County of Lancaster.

303,003. Improvements in and relating to Ignition Devices for use with Fire Grates Burning Solid Fuels. Sulzer Freres Societe Anonyme, of Winterthur, Switzerland.

Accepted July 1, 1929

314,886. Separation of Dust from Boiler Flue Gases. James Thomas Baron, Wood Dale, Bells Chase, Great Baddow, Chelmsford, and Joseph Bernard Clarke, 210, Gloucester Terrace, Hyde Park, London, W. 2.

Accepted July 5, 1929

315,007. Improvements in or relating to Steam Separators. Thomas Morgan Barlow, of "Wraydene," Burnham, County of Bucks, and Gerald Lyon, Ash Cottage, Harlington, County of Middlesex.

Accepted July 10, 1929

314,287. An Improved Process for the Prevention and Removal of Boiler Scale. James Yate Johnson, of 47, Lincoln's Inn Fields, County of London.

Accepted July 11, 1929

315,184. Improvements in and connected with Chain Grate Stokers. Babcock & Wilcox Limited, of Babcock House, Farringdon Street, London, E. C. 4, and Alfred Edward Parker, of the same address.

315,075. Improvements in Underfeed Stokers. James Yate Johnson, of 47, Lincoln's Inn Fields, County of London.

Accepted July 14, 1929

315,781. Improvements in Crushing Mills. Ernst Curt Loesche, of 60A, Kaulbachstrasse, Berlin-Lankwitz, Germany.

Accepted July 15, 1929

315,471. Improvements connected with Superheaters. Babcock & Wilcox Limited, of Babcock House, Farringdon Street, London, E. C. 4.

315,466. Improvements in Fuel Burners. Babcock & Wilcox Limited, of Babcock House, Farringdon Street, London, E. C. 4.

315,449. Improvements relating to Steam Generators. Edward Cock, of Saltash, King's Park, Kowloon, Hong Kong.

315,467. Improvements in Boiler Gauge Glasses. Babcock & Wilcox Limited, of Babcock House, Farringdon Street, London. E. C. 4.

315,473. Improvements in and connected with Steam Generator. Babcock & Wilcox Limited, of Babcock House, Farringdon Street, London, E. C. 4.

Accepted July 16, 1929

315,732. Improvements in Means for Cleaning the Tubes for the Passage of Heated Gases or Products of Combustion in Steam and other Boilers and the like Heated by Waste Heat or other Heated Gases or Products of Combustion Made to Pass through Tubes therein. John Summers and Sons Limited, of Hawarden Bridge Steel Works, Shotton, County of Flint, and Frederick Arnold Hibbs, of "Romiley," Wepre Avenue, Connah's Quay, County of Flint.

Accepted July 17, 1929

315,741. Improvements in Steam Boilers and Method of Operating the same. Babcock & Wilcox Limited, of Babcock House, Farringdon Street, London, E. C. 4.

Accepted July 18, 1929

304,152. An Improved Pulverizing Mill. Hartstoff-Metall Aktiengesellschaft (Hametag), of 39-42, Kaiser-Wilhelmstrasse, Berlin-Copenick, Germany.

302,164. Improvements in Feed Water Heaters. Societe Francaise Des Pompes Et Machines Worthington, at 1, rue Des Italiens, Paris (Seine), France.

315,629. Apparatus for Cooling Superheated Steam. Franz Scheinemann and Franz Seiffert & Co. Aktiengesellschaft, both of 13, Oberwasserstrasse, Berlin, C. 19, Germany.

292,508. Improvements in and relating to Stokers and the like. Wilburt Ward, County of Harden, Ohio, and now of 313, West Carroll Street, Kenton, Ohio.

315,543. Improvements in and relating to Feed Water Heaters. John Ralph Bazin, of "Elmstead," Hendon Lane, Finchley, London, N. 3, and Albert George Burnell, of "Glenthorpe," Hannaville Park, Terenure, Dublin, Ireland.

293,297. Improvements in and relating to the Superheating of Interstage Steam by Means of High-Pressure Steam in Installations Working at Two or More Pressures. Schmidt'sche Heissdampf-Gesellschaft, mit Beschrankter Haftung, of Rolandstrasse, 2, Cassel-Wilhelmshohe, Germany.

315,510. An Improved Apparatus for Automatically Indicating and Recording the percentage of Carbon Dioxide Gas Contained in the Combustion Gases of Furnace Flues and the like. Abraham Lumb, of Copley Dene, Victoria Road, Elland, County of York, and Levi Lumb, of Aldwyn, Green Royd Avenue, Halifax, County of York, both Directors of James Lumb & Sons, Limited, Perseverance Engine Works, Elland.

314,906. Improvements in or relating to the Washing of Smoke and Fumes from Furnaces and the like. Verner, Russell Chadwick, of 238B, Gray's Inn Road, London, W. C. 1.

Accepted July 22, 1929

316,163. Improvements in or relating to Superheater Elements. Serge Tschusoff, of Kanawino, Gouv. Nijni-Nowgorod Union of Socialist Soviet Republics.

Accepted July 23, 1929

316,120. Improvements relating to Underfeed Stokers for Furnaces. George William Johnson, of 47, Lincoln's Inn Fields, County of London.

Accepted July 25, 1929

303,346. Arrangement for Keeping Boiler Feed Water Free of Air and Gases. Societe Des Condenseurs Delas, of 103, rue St. Lazare, Paris, France.

296,023. Multi-stage Steam Power Plant. Siemens - Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

316,037. Improvements in or relating to Water Tube Boilers and Economizers therefor. Harold Edgar Yarrow, of Yarrow & Company Limited, Scotstoun, Glasgow.

316,049. Improvements in or relating to Apparatus for and Method of Making Boiler Headers. John Joseph Cain, of 777 Avenue C, Bayonne, New Jersey.

308,760. Improvements in Retort Ovens for Low Temperature Carbonization. Compagnie Generale De Distillation Et Cokefaction A Basse Tempera-Miniere "Holcobami" Societe Anonyme, of 1, Poststrasse, Glaris, Switzerland, a Company organized under the laws of Switzerland, assignees of International Holding De Distillation Et Cokefaction A Basse Temperature Et Miniere "Holcobami" Societe Anonyme, of 5, rue de l'Arsenal, Brussels, Belgium.

316,058. Improvements in Water Tube Boilers. Harold Edgar Yarrow, of Yarrow & Company Limited. Scotstoun, Glasgow

316,059. Improvements in Furnaces with Travelling Grates. Dr. Lebrecht Steinmuller, and Dr. Carl Hugo Steinmuller, trading as L. & C. Steinmuller, of Gummersbach, in the Rhine Province, Germany.

315,930. Improvements in the Method of and Apparatus for Removing Oil, Grease and the like Foreign Matter from the Interior Surfaces of Steam Condensers. Sterry Baines Freeman, of 22, Palm Grove, Birkenhead, County of Chester, and Imperial Chemical Industries Limited, of Broadway Buildings, 50-60, Broadway, Westminster, London, S. W. 1.